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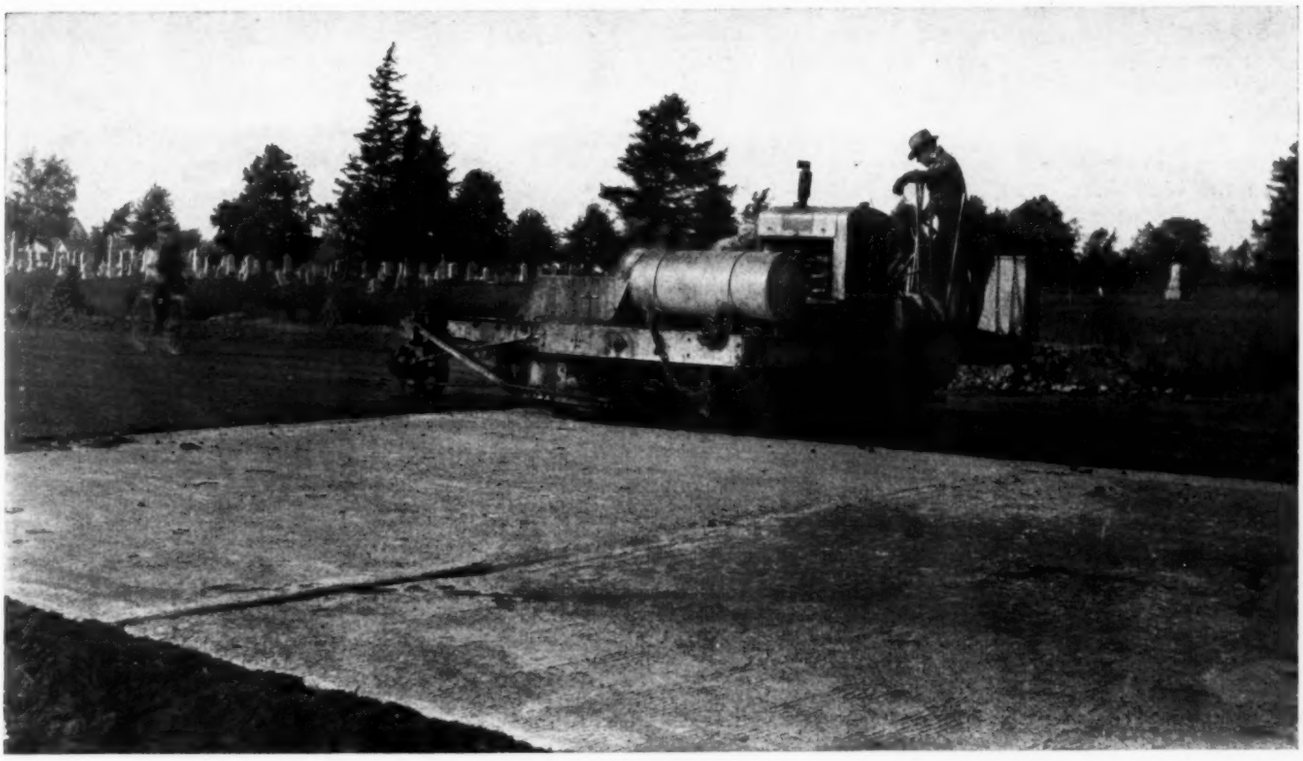

Bituminous paver joins base course to course already laid and rolled on the Buffalo-Niagara Road, Parts 2 and 3

Bituminous Paver

SPREADS AND FINISHES

Coarse Aggregate Type Plant Mix

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ECONOMIC conditions prevailing during the past few years have had a marked influence on highway design and construction. The engineer has been faced with the problem of constructing the greatest possible mileage with the money available. The contractor, due to the great reduction in the amount of construction work, has had to reduce the costs to a minimum, in order to secure work under the severest competitive bidding since the World War. The design and construction of portions of the Niagara Falls-Buffalo Road, Parts 2 and 3, 3.8 miles in length, in the State of New York, is an illustration of how both of the factors in this problem were met.

Several years ago, due to the heavy traffic in the metropolitan area around the city of Buffalo, it was decided by the State Highway Commission, to modernize all the highways on the state system which radiate from the city. To date, this has been fairly well accomplished. Most of the old highways carried 16 foot pavement. The more important ones have been widened to 40 feet. Those slightly less important have been widened to 30 feet. All have been built with a heavy cross-section of pavement. The particular section of road covered by this article, lies in Niagara County on one of the main routes between the city of Buffalo and the city of Niagara Falls and is immediately adjacent to the city of North Tonawanda. This section was the last portion of this particular road to be widened, and this route called for a 40 foot pavement.

The country traversed by this highway is very flat

and the soil is a red clay. The highway is parallel to a small, sluggish stream throughout its entire length, so that the only problem of surface drainage was to provide sufficient cross culverts to carry the run-off to the creek. Most of these culverts had been placed when the highway was first improved in 1912-1913. They required lengthening. It was also necessary to construct a few new ones.

The road had been constructed with a brick pavement 16 feet wide. On one portion of the road the pavement had been given a 2-in. crown. On another section the surface of the brick had a slope of ¼ in. per foot all in one direction. On this section, one edge of the brick lay practically in the center line of the highway and the slope of the pavement surface was away from the stream. On the creek side there had been constructed a wide earth shoulder with a slope approximating ½ in. per foot. There were numerous curves on this highway, several of which, had rather short radii. No banking of these curves had been employed. In general, the old brick pavement was sound, although there were sections of it where the base had yielded and the brick had been pounded down. This failure had occurred largely along the center line of the pavement. To maintain a suitable surface, the affected areas had been repaired from time to time with cold patch.

In the design, the problem was to utilize as much of the old brick as possible. It was considered desirable not to have two types of surface on this section of highway. Therefore, it was decided to use the brick as a foundation for a bituminous top. After considerable study the following design was adopted: The old brick pavement was to be widened with concrete to serve as a foundation. Over this foundation was to be placed a plant mixed bituminous top, using New York State specifications for bituminous macadam mixing method Type 3, a brief outline of the specifications for which are given below. The minimum thickness of this macadam was to be 2 in.

In order to bring this highway up to the standards of modern practice, it was necessary to realign some of the curves. Also it was necessary to bank many of the curves. This meant that not all of the old brick could be utilized as a base for the black top. However, largely by increasing the depth of the bituminous top over the old brick, where necessary, the design of the new pavement was so adapted to existing conditions that practically 80 per cent of the old pavement was salvaged. In order to further stabilize the pavement, and due to the clay sub-soil, it was deemed advisable to place a foundation course six inches thick under the new concrete base. The contractor was given the option of constructing the foundation course of run of bank gravel, slag or crushed stone. Slag was used. Also, the design provided for weeps of the same materials as the foundation course for under drainage.

On this particular contract, the specifications for the concrete foundation for pavement permitted the use of either gravel, stone or slag as coarse aggregate. In as much as there was a slag plant within about 2 miles of the contract, the contractor elected to use this material.

Specifications for the concrete foundation on this job were practically the same as regards to forms, mixing time, water, manipulation and curing, as required by the state for first class concrete pavement. There were two exceptions to the above. One of these was, that ½ in. variation from a true surface was allowed under a 10 ft. straight edge. The other, was that where a concrete pavement surface normally requires brooming, this surface was given a finish by slightly corrugating it with the tines of a rake. In order to accomplish this satisfactorily, a rake with curved tines was used and the goose neck of the rake handle was straightened out so that the tines of the rake were in line with the handle. The rake was then drawn across the concrete with the convex side of the tines down. This left corrugations in the surface of the concrete from ⅛ in. to ¼ in. deep, and did not displace the coarse aggregate.

The top course of bituminous macadam mixing method Type 3 is a cold mix. It is generally laid on either a concrete or a broken stone foundation and the following points governing its preparation and handling are taken from the specifications.

"The formula used for preparing the asphalt paving mixtures shall be set to proportion them to the best advantage from the materials hereinafter specified, but not to exceed the following limitations:

Materials	Coarse Mix Per Cent	Fine Mix Per cent
Broken rock	86 to 92	83 to 90
Naphtha (a) or (b)	.4 to 1	.4 to 1
Asphalt cement	4 to 6	5 to 8
Hydrated lime	.5 to 1	.5 to 1
Fine aggregate	3 to 6	5 to 9

"Broken rock for the coarse mix shall have the following gradation:

No. 2 size (Retained on ⅝ in. sq.—Passing 1 in. sq.) 80% to 100%

No. 1 size Retained on ¼ in. sq.—Passing ⅝ in. sq.) 0% to 20%

"Broken rock for the fine mix shall have the following gradation:

No. 1 size (Retained in ¼ in. sq.—Passing ⅝ in. sq.) 55% to 85%

No. 1-A size (Retained on ⅛ in. sq.—Passing ¼ in. sq.) 15% to 45%

"The broken rock shall be passed through a rotating cylindrical drier. It shall be heated by hot gases, not by direct flame, to a temperature sufficient to drive off all of the moisture so that as it comes from the drier it will have neither surface nor contained moisture. Broken rock leaving the drier at a temperature greater than 110° F., shall be stored in stock piles and entirely protected from the weather until the temperature reaches that specified. In no case shall the temperature of the broken rock be less than 50° F. No hot stone shall be placed in a storage pile bin while other materials are being used from it. After it has cooled to the temperature specified, it shall be screened and placed in covered bins with three or four compartments and of a capacity ample to insure production schedules.

"Naphtha.—The naphtha shall meet one of the following requirements, as determined by the engineer and the amount used shall in every instance be greater than that which can be absorbed by the surfaces of the mineral aggregate.

"(a)—Light naphtha shall be a petroleum distillate which when distilled in accordance with A.S.T.M. D-80-30 shall have an initial boiling point of not over 220° F., and an end point of not over 450° F. At least 45 per cent of the distillate shall be distilled over at 325° F.

"(b)—Heavy naphtha shall be a petroleum distillate which when distilled in accordance with A.S.T.M. D-80-30 shall have an initial boiling point of not over 150° F., and an end point of not over 525° F.

"When fifty per cent of the distillate has distilled over, the temperature shall be between 290° F. and 360° F. The flash point of the heavy naphtha shall be below 80° F. Light naphtha shall be used in all cases unless otherwise shown on the plans or ordered in writing by the Deputy Commissioner."

The asphalt cement is required to have a penetration

(77° F., 100 grams, 5 seconds) of not less than 85 nor more than 100. Texaco asphalt was used by the contractor. Hydrated lime is to meet the requirements of the A.S.T.M. Fine aggregate is cleaned, crushed rock screenings, 100 per cent of which will pass a ⅛ in. screen. It is required that the mixture shall be proportioned by weight with the exception of the hydrated lime which is proportioned by volume on the basis of volume weight relation.

The specifications require that this paving material shall be transported to the site of the work in clean trucks. Upon arrival on the work the mixture shall be deposited on platforms outside of the area on which it is to be spread, the entire load distributed into place, and spread by suitable means in a uniform layer as shown on the plans. This material shall then be rolled and if any depressions appear they shall be filled immediately with additional mixture and again rolled until the surface is even and to the grade and cross-section given. After this preliminary rolling the fine mix shall be spread and rolled in a uniform layer, as shown on the plans. The fine mix shall constitute 25 per cent and the coarse mix 75 per cent of the thickness of this item unless otherwise specified. A variation of ¼ in. from a true surface under a 16 ft. straight edge is the maximum that is allowed by the specifications on this type of pavement.

Normally, this type of pavement has been placed by hand methods. In order to facilitate operation of the plant, it has been customary to place the coarse mix, which is the bulk of this pavement, for at least a day and then follow up with the fine mix. Occasionally two days have elapsed, and, in adverse weather even more than this, between the time of placing the two courses. However, no difficulty has been experienced in securing

Foundation for New Surface Is an Old Brick Road Widened With Concrete

Dumping the Plant Mixed Surface Course Mixture Into the Hopper of the Bituminous Finisher

a thorough bond between the courses. It must be noted, however, that every effort is made to prevent dirt or any foreign material getting on the first course before the second course is laid. This macadam is rolled with tandem rollers, weighing approximately 8 tons and it is required that one roller shall be in use for each 1200 sq. yd. or fraction thereof, of this pavement laid per day. In order to thoroughly consolidate this pavement, considerable rolling is required, after the pavement surface is well ironed out. For this work, a three wheeled roller, weighing 10 tons, has been found more advantageous than the tandem roller. The specifications also require that after laying the top course, a dressing of clean sand or grit, 90 per cent of which will pass a 14-mesh laboratory sieve and 75 per cent of which will be retained on a 48-mesh laboratory sieve, shall be uniformly spread at the rate of approximately 6 to 8 pounds per square yard of pavement and within 24 hours after the fine mix has been placed and rolled. It is the opinion of the writer that superior results can be obtained by using slightly more of a well graded concrete sand. The fine sand either sifts to the bottom of the pavement or is lifted by fast automobile traffic and blows off. On the other hand, some of the larger particles of the coarse sand will scatter to the edges of the pavement under traffic. However, when concrete sand is used the texture of the pavement surface is, in general, denser and more closely knit.

On this particular contract, the contractor attacked his problem with the idea that constant progress would be his salvation. He was limited by an "Unemployment Relief" act of the state legislature, which restricted the hours of employment for labor to 8 hours per day and 5 days per week. This applied to all employes except those in a supervisory capacity.

The contract was let in the middle of the summer and the contractor started operations on July 11, 1932. The contractor was required to keep two lanes open for traffic during construction operations. In the main, this was fairly simple, as he had the old brick pavement for traffic. His first operations were, of course, installing the necessary culverts and grading. His pavement operations consisted of three distinct steps. He had to first fine grade and put in his foundation course, run of bank gravel, slag or stone. As noted above, due to the proximity of the slag plant he used slag for this purpose. After this was well under way he started his concrete foundation for pavement. For this purpose he set up his batching plant in the yard of the slag company. This batcher was designed for proportioning aggregate either by weight or by volume. Due to the variations in the specific gravity of the slag it was proportioned by volume. To obviate corrections for bulking, the sand was proportioned by weight. In an endeavor to further reduce his operating costs, the contractor also used bulk cement. He set up a Blaw-Knox cement weighing plant and delivered the cement to this plant by truck from one of the mills in the city of Buffalo. Dump trucks were used. The trucks dumped into a hopper, reached by a short ramp, and the cement was elevated to the overhead bin of the weighing plant. The bodies of the trucks were roofed over to protect the cement from sudden rain storms and to prevent its blowing away while in transit.

Batches were hauled to the mixer in three compartment dump trucks. The contractor operated with two shifts a day and by so doing was able to secure 16 mixer-hours for the most of his concrete work. In as much as the widening of this highway was not all on one side of the brick pavement, after the contractor had worked his mixer over about half the length of the contract, he

returned to the beginning and placed the concrete foundation on the other side of the brick. By this time, the concrete first laid had cured sufficiently for traffic to be maintained upon it. After these two operations were complete, it was necessary for the contractor to remove the old bituminous patches which had been placed on the brick and patch with concrete, such areas of the old brick as he was directed. In general, for these patches, the brick and sand cushion were removed and the concrete of the patch was placed on top of the old concrete foundation of the brick pavement. High early strength cement was used for these patches and during summer temperatures these patches were opened to traffic within two days.

The contractor sublet the placing of the bituminous macadam to the Webber Company of Jamestown, N. Y. This company brought in a semi-portable asphalt plant equipped with a 1½ ton mixer. This plant was set up in the city of North Tonawanda, about 2½ miles from the job. The site chosen had both rail and water facilities. Stone was delivered by boat from Wisconsin. A drier for the stone was installed and was highly essential, as this stone was washed product and was delivered fairly wet. Asphalt was brought in by rail. Fine aggregate was delivered by rail. There was nothing particularly unique about this set up other than the contractor availed himself of water rates on the stone.

As noted above, it has been customary to resort to hand methods in placing this material. I might mention at this point that the mix as adopted on this particular contract contained the following proportions:

Materials	Fine Mix Per Cent	Coarse Mix Per Cent
Stone	84	90.9
Asphalt cement	6.5	4.6
Filler	9.0	4.0
Lime	0.5	0.5
	100	100

Liquifier is not considered as part of the batch and approximately 1½ gallons of naphtha (a) per ton were used in the coarse mix and two gallons per ton in the fine mix. This gives rather a stiff, hard working material. The contractor was aware of this and proposed to bring in a finishing machine of a type which he had operated successfully in the eastern part of the state. He was told that he might try this machine out and if it proved to be satisfactory he would be allowed to use it, otherwise, he would have to resort to hand methods.

This machine is manufactured by the Adnun Engineering and Manufacturing Company. It is power driven and consists essentially of a hopper into which the black top is dumped, a revolving shaft equipped with blades which draw the material down through the hopper to the foundation and a saw toothed blade, very similar in design to the cutting bar on a mowing machine, for cutting the material off to an even surface. This cutting bar or screed is placed below and just back of the hopper and has a throw of about 6 or 8 inches. The machine can be adjusted for varying depths from ½ in. to 4 in. and can lay widths from 6 ft. to 10 ft. The machine is equipped with two small wheels in front, which are placed about 6 ft. ahead of the hopper and two roller type wheels 24 in. in diameter and 2½ ft. long which are about 3 ft. in back of the hopper. The latter run on the surface of the black top. All four wheels are power driven. The wheels in front are used for steering. Either of the rear wheels can be thrown out of gear to facilitate turning the machine around. The frame work of the machine is so constructed that there is ample space between the supports carrying the front wheels for a truck to back into the hopper. The machine is powered with a gasoline motor and one man is required to operate it.

The machine was tried out first by laying the two outside strips 10 ft. wide and then filling in the two center strips. In order to provide a uniform texture to the pavement and to do away with visible joints between adjacent strips, it is necessary not to roll the full width of a 10 ft. strip until the adjoining strip is placed. In this way, where two strips join, the rolling is done with both in place and the material of both strips knits together to form a pavement with little or no visible longitudinal joints.

Placing the two outside strips first and then filling in the center had the disadvantage of putting the machine, when it was laying the last strip, between the two loose edges of the adjoining strips. Slight variations in the alignment in placing the first strips would sometimes leave somewhat less than 10 ft. for the last strip. In as much as the front wheels of the machine were fixed at 10 ft. out to out of wheels, this forced the wheels, at times, through the loose edges of the adjoining strips and they lost their traction. Therefore, it was decided to lay the pavement from one side to the other in 10 ft. widths.

The contractor had, on the average, the following crew in addition to the roller men: 1 foreman; 1 machine operator; 2 rakers; 6 laborers.

Three of these laborers were employed in preparing the shoulder at the edge of the pavement as described below.

One laborer tended to the dumping of the trucks and if there was any considerable amount of spillage from the truck in front of the machine, he forked this into the hopper of the machine.

One laborer was kept around the machine as a handy man. He had to clean the rear rollers and oil them to prevent their becoming clogged with the black top as this cold mix is exceedingly sticky. This oiling, by the way, can be overdone to the detriment of the pavement and requires constant watching. This man also, on occasion, helped with forking up any spillage.

As noted above, occasionally the machine would veer slightly from the alignment of the highway. Sometimes this was due to the inattention of the operator. Regardless of the cause, it generally resulted in too much or too little material being deposited at the junction of two strips. These were dressed up by hand and the two rakers were kept on hand for this purpose. However, due to the stiffness of the material, small spots, where insufficient material had been placed, showed up after the first rolling. As a rule, there were none much larger than a man's hand but they had to be filled up. The bulk of the time of the rankers was employed on this work. Usually, such work is done by common laborers. However, the contractor had the rakers on the job and used them. The machine certainly made no more of these spots than hand raking would have done and probably less.

The third laborer was used on this work of filling in and to assist the rakers when necessary.

Normally, with hand operations, in order to secure an even edge, it is necessary to place wooden forms on the shoulder of the road against which to lay the black top. It was found that the machine gave a satisfactory edge without the use of these wooden forms. In fact, with the machine, it is probable that such forms would be a detriment rather than an advantage. However, it was deemed advisable to build up the earth shoulder approximately to the height of the black top. To accomplish this, a few 2 in. plank were placed on the edge of the concrete as a guide and two or three men filled in earth against these boards and tamped it solid with rammers.

The boards were then moved ahead and used over and over again. This not only did away with the expense of paying for considerable form lumber but the number of men employed was less than would be required had it been necessary to place wooden forms.

In the beginning it was thought necessary to bring up any low areas in the old brick pavement to approximately the grade of the surrounding surface in advance of covering this with a course placed by the machine. However, subsequently, it was found that this was a distinct disadvantage as the machine itself would take care of these irregularities more satisfactorily than they could be taken care of by hand. This applies to irregularities which were ½ in. to 1½ in. in depth. However, where, due to banking of curves or some other cause, it was found that two or three inches of this black top material had to be placed below the normal 2 in. course, such areas had to be filled in by hand and thoroughly consolidated by rolling. It was found that this machine gave a smoother, easier riding surface than we had been able to secure previously with hand methods. It also reduced the labor cost of laying, to a marked extent. The machine was capable of handling more material than was furnished by the particular plant on this job.

The black top was started on September 20, 1932, and practically completed on November 15, 1932. Some minor work was all that remained to be done. The contractor was not allowed by the specifications to place this black top when the air temperature was below 50° F. This is a heavy handicap on progress in the fall but is necessary with this material. This factor must be taken into consideration in analyzing progress on this portion of this contract.

Laying the Top Course Over the Base Course. Roller Follows Closely

The T. J. McDermott Contracting Corporation of Lackawanna, New York, were General Contractors on the project. The job was in direct charge of Mr. Heber Ashley, Assistant Engineer, working under Mr. Chas. R. Waters, District Engineer of the New York State Department of Public Works, at Buffalo, New York.

Description of Machine.—[By the editor]. The frame of the machine is approximately twelve feet wide and thirteen feet long over-all. The front end of the machine is carried by two twenty-inch diameter, six-inch face wheels, mounted on projections which extend beyond the machine proper for the purpose of obtaining a relatively long wheelbase. A twenty-four horsepower gasoline motor drives both the rollers in the rear and the wheels in front.

A steel hopper ten feet in width with a capacity of approximately three tons of material, extends across the central portion of the machine. This hopper has an adjustable front end for varying the width of opening at the bottom and regulating the flow of material from the hopper onto the sub-grade. Parallel with the opening in the bottom is a raker bar with raker teeth pitched at an angle so as to spread the materials evenly throughout the length of the hopper, break up any lumps and assist the flow of material from the hopper onto the sub-grade.

Directly at the bottom and rear of the hopper is a reciprocating cutter bar having undercut beveled teeth, not unlike those used on a mowing machine, which cuts off the material as it comes from the hopper and passes over it, compressing and leveling it off in measured thickness. The cutter bar is carried on heavy springs and is adjustable for varying the thickness from ½ in. to 3½ in., also for crowning and banking curves. When the adjustment is once set it will continue to produce the same thickness of material until changed.

In operation, the truck backs up between the front wheels, which run inside the shoulder on the sub-grade, and dumps a portion of its load, approximately three tons, into the hopper, and then pulls ahead out of the way.

After a short period of operation it is possible for the operator of the machine and truck drivers to so coordinate their movements by a system of signals that there is very little time lost in discharging a truck load of material.

Finished Roadway Is Forty Feet Wide

Material is usually hauled in trucks carrying from six to eight tons and three dumps are required from the truck into the hopper to discharge this size truck load. Time required for discharging a full truck load varies, of course, with the type and thickness of material being laid and the efficiency of the organization but generally runs from four to eight minutes.

It has been found from experience that not to exceed three men are required for the successful operation of the machine, depending upon the conditions of the job.

On an uneven roadbed the machine automatically produces a level surface, filling in the depressions and smoothing out the irregularities so that when the surface is rolled it will show practically no variation, giving a smooth riding road without bumps. The surface can be crowned or curves banked by adjustment of the cutter bar at either end or in the center.

No form setting or headers are required, due to the fact that the front wheels run directly on the sub-grade and the rear rollers on the freshly laid surface. Edges are trimmed square and butt joints made which cannot be detected after rolling.

Varying widths of road can be laid down by the use of partition covers in the hopper.

Highway Construction Produces *Railroad Traffic*

By J. L. HARRISON
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IN the various discussions of the effect of highway construction on railroad traffic which have recently appeared in the public press, there has been little or no reference to the volume of traffic the railroads obtain as a direct result of highway construction. The natural implication of this omission is that the volume of this traffic is so small that whatever traffic has been lost by the railroads on account of the existence of improved highways is a net loss. Nor is this an altogether unnatural conclusion for the use that is made of railroad facilities in delivering materials for highway construction does not invite general attention. On this account the following analysis of the traffic which the railroads receive as a direct result of state highway construction may be of general interest, though, in the nature of the case, many of the conclusions must be reached by the process of reasoning from known facts. But if, on that account, there is an absence of detail, little is thereby lost, for it is more important to know the order of importance of highway construction as a source of railroad freight than to know the exact tonnage handled. This, the analysis which follows, develops.

Aggregate Largest Freight Item.—The largest freight generating item in any highway construction program is the sand, gravel, broken stone and slag used principally for concrete work, including concrete surfaces, but to a considerable extent in other types of surfaces. During 1931

9,664 miles of concrete pavement,
161 miles of brick pavement,
749 miles of bituminous concrete pavement,
1,939 miles of bituminous macadam pavement, and
1,453 miles of waterbound macadam pavement

were built on the state highway systems of the United States. This is a total of 13,966 miles of pavement all of which was potentially a source of revenue freight on account of the sand, stone, gravel, slag and other materials used in constructing these surfaces. In addition to the above mileage, 16,801 miles of gravel and chert surfacing were laid down and some 3,772 miles of sand-clay or topsoil surfaces. Normally, these surfaces yield little or no revenue freight, but the drainage structures, bridges, etc., built in connection with these improvements yield a limited amount as the average yardage of concrete used for structures (based on figures not presented here) appears now to be about 120 cu. yd. per mile of pavement built. This does not take into consideration the large mileage constructed off the state system.

The surfacing noted above and the structures built in connection with it required the use of about 60,000,000 tons of aggregate of which about 17,000,000 tons was sand. The balance was principally gravel and broken stone, though it included some slag.

42,000,000 Tons Sand, Gravel, Broken Stone and Slag Moved by Rail.—Just how much of this material moves by rail, it is not possible to say with a great degree of exactitude. A year ago a study was made of the facilities used in bringing materials to some 375 Federal-aid projects. This study indicated that the cement was delivered by rail to 98 per cent of the projects reporting the manner of delivery, that sand was delivered by rail to 74 per cent of these projects and that other aggregates were so delivered to 72 per cent of these projects. A more extended study of this matter is now under way and a preliminary examination of the detailed reports so far received shows that 68 per cent of the sand, 57 per cent of the gravel, 85 per cent of the broken stone and 92 per cent of the cement that is being used on the projects from which reports have been received is being delivered by rail. This would indicate that in a general way about 70 per cent of the sand, gravel, broken stone and slag used in highway construction during 1931 or some 42,000,000 tons was moved by rail.

Cement Made 11,000,000 Tons of Freight.—In building the highway mileage noted above, including structures, some 45,000,000 bbl. of cement were used. As more than 90 per cent of this cement was moved by rail, it appears reasonable to conclude that at least 8,000,000 tons of revenue freight resulted. To burn this cement, some 2,500,000 tons of coal were used. This, too, is revenue freight directly traceable to activity in the highway construction field.

Gypsum for this cement generated approximately 250,000 tons of freight. Explosives for use in the quarries also generated a considerable tonnage. There was, finally, a considerable tonnage in miscellaneous items such as bag returns, repair parts, kiln supplies, etc. In gross, the freight generated by gypsum, explosives, bag returns, miscellaneous supplies, etc., for the cement shipped to highway construction jobs during 1931 must have exceeded 500,000 tons. In short a total of over 11,000,000 tons of freight would appear to have been handled by the railroads as a result of the use of cement in State highway construction.

Steel Created, 3,500,000 Tons of Freight.—Such figures as are available indicate that the 1931 State highway program involved the use of about 500,000 tons of steel as reinforcing in concrete pavement and concrete structures and in steel structures. Practically all of this generated revenue freight. In addition to this, a considerable tonnage of steel is used in pipe culverts, in wire for guard rail and fences and in miscellaneous small items. Such figures as are available suggest that at least 20,000 tons of galvanized pipe were used in culverts. If to this there is added the tonnage of wire used in guard rail and in right of way fencing and the tonnage of steel used in miscellaneous minor items, it is probable that the total of other than reinforcing steel and structural steel was at least 100,000 tons.

But the revenue freight that was involved is much greater than the tonnage of finished material. Some four tons of material—ore, coal and flux—must be handled in order to produce a ton of pig. The tonnage of

steel is, of course, much greater than the tonnage of pig produced annually, but much of the scrap must be moved by rail and the conversion of pig into steel involves the use of a great deal of coal as a source of both power and heat. Freight is also generated by the movement of the various materials used in converting pig into steel as well as by the delivery of materials for the maintenance and the repair of the furnaces and the mill equipment. In total this movement is in such volume as ordinarily to generate at least five tons of freight movement for each ton of steel produced with the result that though the steel used in the highway construction field is of the order of 600,000 tons, the total freight involved in the use of this steel, including its delivery to the site of the work, would appear to be of the order of 3,500,000 tons.

Asphalts, tars and road oils used in the original construction of the State highways built during 1931 appear to have been in the neighborhood of 250,000 tons. A much larger tonnage was, of course, used in maintenance operations and in street construction with which we are not concerned here. Practically all of this tonnage was moved by rail, but as the crude oil out of which it is made is largely handled through pipe lines and by water and as fuel oil rather than coal is the source of both the power and the heat used in the refineries, there is no large volume of subsidiary railroad freight generated by the use of these bituminous materials.

The brick used in constructing the 161 miles of brick pavement weighed over 250,000 tons and most of it involved some rail haul. Some secondary freight is involved in the manufacture of brick, the principal item being coal for fuel, but as the amount of this subsidiary freight is not large—probably not over 20,000 tons—the round figure, 250,000 tons, will be taken as fairly indicative of the tonnage developed by the brick used in highway construction during 1931.

The Freight Contribution of Construction Equipment.—Movements of equipment also generate a great deal of freight. This freight is of two kinds—the delivery of new equipment and the movement of equipment from job to job. At the peak of the 1931 construction season, the following heavy equipment was at work on highway construction:

2,150 power shovels
1,175 cranes
700 pavers
1,750 mixers (usually 1 or 2-bag)
1,775 rollers
24,500 trucks
5,450 tractors.

Normal replacements on this equipment, together with the large amount of lighter equipment used, should generate well over 5,000 carloads of freight or in the neighborhood of 200,000 tons of revenue freight. As in the case of steel, the amount of freight generated by the collection of the materials for the manufacture of the steel out of which this equipment is built, and its transfer to the factories that build accessories and then to the factories which build the equipment, is large. Indeed, it is entirely probable that from 6 to 7 tons of freight are moved on account of each ton of equipment finally sent to the field, with the result that the gross tonnage of freight represented by the normal annual supply of new equipment for the highway field probably exceeds 1,500,000 tons.

After the equipment reaches the field, it must be moved from job to job and in the case of heavy equipment this usually is a matter of a rail haul. There is little data as to the amount of freight so generated. Some jobs generate none, a good many jobs generate 2 or 3 carloads of this sort of freight. Some a good deal more. Certainly the freight so generated during 1931 was not less than 10,000 carloads and may have exceeded 15,000 carloads. It is estimated in very round numbers at 500,000 tons. This may seem a high estimate, but is believed to be too low rather than too high, though there has been some tendency for it to fall during recent years as more and heavier trucks have been made available to the contractors.

State Highway Construction Furnished 60,000,000 Tons Revenue Freight.—These are the principal items out of which the railroads derive revenue freight as the direct result of activity in the highway construction field. In total they amount to nearly 60,000,000 tons. In dollars, the 1932 highway program was somewhat less than the 1931 program, but in mileage the reduction is not as great. During 1931, 877,462,600 tons of freight were "terminated" by the Class 1 railroads of this country. The 1932 tonnage will not much exceed 600,000,000 tons. In these items alone State highway construction must, then, have furnished about 7 per cent of the tonnage handled by the railroads during 1931 and nearly 10 per cent of that handled this year. This is an imposing percentage of the total railroad business—one that cannot be sacrificed at this time without doing real damage to these carriers and to the thousands of men who work for them, to say nothing of the tens of thousands whose life savings are invested through the insurance companies and the savings banks in railroad securities.

In closing this discussion, which in the interest of brevity has been limited to a development of the major points at which railroad tonnage is developed by activity in the highway construction field, it may be observed that the reduction in railroad tonnage—now under 50 per cent of what it was in 1929—is primarily due to widespread and very general reductions in construction activity. All kinds of heavy construction—residences, apartment buildings, office buildings, factories, water supply, power plants, etc.—involve the movement of large amounts of material, much of which, but in particular steel and equipment of all sorts, generates a great deal of subsidiary movement. The resulting freight tonnage is enormous. At the moment construction is at a low ebb, and the railroads are suffering because the tonnage usually to be had on account of construction activity is not now available in anything like normal volume except in the highway field where the volume of business still is well maintained. To destroy activity here can, then, only add to the difficulty of the position of the railroads for the destruction of activity in the highway field would eliminate the sole remaining construction activity that is producing a normal volume of railroad tonnage and that at a time when the crying need of these carriers is more tonnage rather than less tonnage. There is no hope of an immediate development of activity in the construction field, taken as a whole, for, obviously, most of this field is now badly overbuilt. This is not true of the highway field where a considerable amount of additional construction can be used to advantage. Both public interest and the interest of the railroads would seem, then, to be better served by maintaining all possible activity in this field at least until wear and tear and the normal increase in our population create conditions that will cause a natural recreation of activity in other lines of construction work.

Why Bidding Prices on Portland Cement Are Uniform

By HALBERT P. GILLETTE, Editor

RECENT advances in the price of portland cement have led to favorable comment among those who believe that business revival must be preceded by a rise in prices. On the other hand, there has been some criticism of the higher prices, and the old question has been raised as to why the new prices are so uniform. That question was not asked when the price of cement was declining, although there was the same uniformity as to bidding prices when they were "on the toboggan" as there is now when a slow climb up the hill is beginning.

Economists are unanimous in saying that nearly every commodity price is now too low to yield a normal return upon invested capital. And they are agreed that a normal profit must be earned before good times will be with us again. Why, then, are there any critics of rising

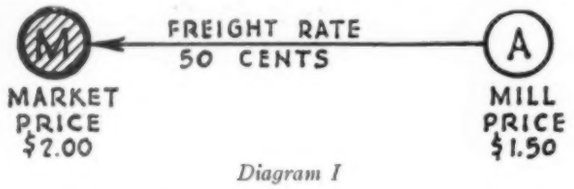

Diagram I

cement prices? Presumably because the uniformity of the bids leads to the inference that it indicates collusion among the bidders. Those who draw such an inference as to cement prices have evidently failed to consider an economic law that applies to every class of uniform product that is sold in an open market, namely, that competitive prices gravitate toward equality.

All portland cement offered for sale is required to conform to a standard specification agreed on by the U. S. Bureau of Standards, American Society of Civil Engineers, and American Society for Testing Materials. This standard is generally recognized by all users of portland cement. Thus it is that portland cement made by any reputable manufacturer is interchangeable with that made by any other such manufacturer. No enlightened buyer will pay more for one cement than for another.

As in the case of wholesale buyers of wheat, sugar or any other standardized product, cement buyers will not pay a premium for one brand of cement which is the same in quality as some other brand. This being so the price at which cement is sold in any market usually equals the lowest price at which it is quoted in that market.

The reason for uniform prices of a standardized product like portland cement was pointed out more than 60 years ago by a noted English economist, W. Stanley Jevons, LLD., M.A., F.R.S. In his book, "The Theory of Political Economy" (MacMillan & Co., Ltd., London, published in 1871) Jevons says:

"When a commodity is perfectly uniform or homogeneous in quality, any portion may be indifferently used in place of an equal portion; hence in the same market, and at the same moment, all portions must be exchanged at the same ratio. . . . Where no difference exists at all there can be no ground for preference whatever. If, in selling a quantity of perfectly equal and uniform barrels of flour, a merchant arbitrarily fixed different prices on them, a purchaser would, of course, select the cheaper ones; and where there was absolutely no difference in the things purchased, even an excess of a penny in the price of anything worth a thousand pounds would be a valid ground for choice. Hence follows what is undoubtedly true, with the proper explanations, that in the same open market, at any one moment, there cannot be two prices for the same article."

Two illustrate this point two examples may be cited: Many dealers handling cement have a place of business in more than one city or town; so-called line yards have headquarters in a city and branch yards in several, sometimes several hundred, towns. They ask manufacturers for quotations on cement delivered at all these towns. Second, a state may ask for bids on cement for highway building purposes delivered at numerous destinations throughout the state.

In each of these two cases the line yard and the state will probably be quoted for each of the destinations exactly the same price from each of ten or more manufacturers of cement. This naturally is considered by some people as conclusive evidence that manufacturers get together and agree on prices. How could it be possible otherwise, they ask, that exactly the same price at each several hundred destinations should be quoted by several different manufacturers? Yet the answer is simple.

Portland cement is sold delivered at a destination designated by the buyer and the price includes freight and charge for the container, usually sacks, in which the

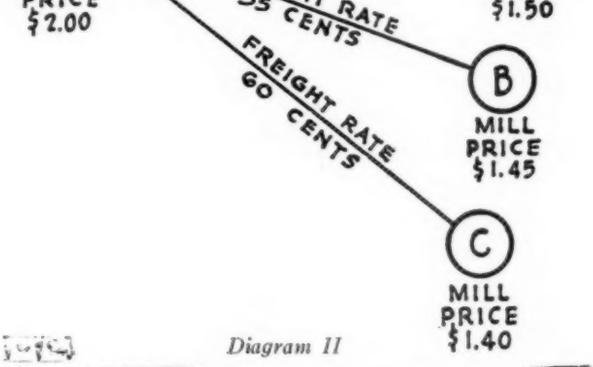

Diagram II

cement is packed. Thus the price paid by the buyer is made up of the manufacturer's price at his mill, plus freight to destination, plus charge for container. When the purchase is made from a dealer his charge for handling and his profit, of course, are included in the price paid by the ultimate buyer.

This is illustrated in Diagram I. A is the mill and M the market or destination. The freight rate from mill to market is 50 cents. The mill price (A) is $1.50 to which is added freight rate of 50 cents, making price at market $2.00. (In this illustration charge for container is ignored.)

The illustration Diagram I is perfectly simple and would remain so if each market where cement is used were supplied by only one mill. But in actual practice there are many mills seeking business in every town or market in the country. This is illustrated in Diagram II.

A, B and C are cement mills. Each seeks business at M, a town or destination with a 50-cent freight rate from A, 55 cents from B and 60 cents from C. This gives A a 5 cents advantage over B and a 10 cents advantage over C. A figures that he can sell at a mill price of, say, $1.50 so he adds the 50 cents freight and quotes $2.00 at M. Then, if B and C want to do business at M they must meet A's price requiring B to go 5 cents below A in his mill price and C to go 10 cents below A in his mill price. Unless B and C can make the mill price sacrifices required by the market at M as made by A's price of $2.00, then A will monopolize the market at M.

In other words, as the economic law precludes a difference in prices of portland cement at the same market at the same time, the place of competition between sellers shifts from the market to the mill. Thus the usually uniform price at any market instead of indicating lack of competition really is the result of severe competition between manufacturers. The variation in price is not at the point of destination but at the mill. While all sellers quote the same delivered price, they each get different mill prices and the manufacturer farthest from the buyer's market receives the smallest mill price for his product.

These two diagrams show why the practice has grown up of selling cement f.o.b. destination rather than f.o.b. mill. On destination sales freight rates are figured by the manufacturer and included in his price. Thus the purchaser is relieved of the burden of figuring freight rates—and freight traffics are complex problems to figure. Furthermore, if prices were quoted f.o.b. mill, each manufacturer quoting in a given market would simply learn the price quoted by the mill nearest that market, add the freight rate from that mill and thus arrive at his competitor's delivered price; then from that price he would deduct his own freight and use the result as his mill price for quotations to purchasers located in the market affected.

But how do manufacturers know what prices are being quoted at a given time at a given market by all other manufacturers? Here again the answer is simple. Every cement manufacturer advises buyers from time to time of his prices at their destinations. This is done particularly at the time of a change in the manufacturer's price by mailing literally thousands of quotations to cement buyers located all over the country. Some of the larger manufacturers also report their price changes to the newspapers. At least one engineering journal of national circulation publishes from time to time a list of prices at important cement mills.

Thus it is easy to learn the exact price of any manufacturer at any time in any market. If any manufacturer should today mail quotations to the trade, many receivers of these quotations would immediately advise other manufacturers with whom they deal. These latter manufacturers learning of such quotations at any market would simply deduct from the price so quoted, freight rates from nearby cement mills and thus learn the mill prices used by those manufacturers who had issued such quotations.

It is the normal circumstance for cement prices to be uniform at a given market at a given time. They simply could not be otherwise. No manufacturer can sell his cement at a destination price higher than that quoted by any other manufacturer. Also he knows that if he quotes a price lower than that quoted by others, the others would meet it. Thus the whole market level would be lowered. This is only another way of saying that no manufacturer can quote higher than the going market price and get any business and he fears to quote less than the market price because if he did so, the market price would be lowered.

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Public Works for Relief of Unemployment*

To illustrate the economy of unemployment relief by public works rather than by taxation to pay a dole, assume a public works construction program amounting to 3 billion dollars. This involves a charge for interest and amortization of about $150,000,000 a year. It is estimated that such a program would give employment to between 1,500,000 and 2,000,000 workers per year, distributed between the construction work and the many industries that serve construction. To support these same workers in idleness would cost the community between $750,000,000 and a billion dollars a year, as compared to interest charges of $150,000,000 on a public works program.

Money expended in doles or direct relief contributes little to the stimulation of trade, whereas money spent in public works stimulates business not only in the community itself but throughout the material and transportation industries. If the money for a dole is to come out of taxes, as it properly should, since it is ruinous to borrow money to give away, the present burden on the taxpayer would be actually relieved through a public works program because the taxpayer will only have to bear the interest charge on the monies expended. If the government and its subdivisions must borrow to effect economic relief, it will be far better to invest the funds so raised in community facilities, thereby conserving the public wealth and stimualting a normal resumption of trade.

The majority of the unemployed in this country do not want a dole—they want work. An attempt recently in one of our large cities to transfer unemployed from work relief to the dole met with such protest that it had to be abandoned. Those employed on work relief or public works retain their social status and their self-respect, while those on direct relief or the dole tend to become demoralized and discouraged. It is a distinct question whether a large number of those who have been on direct relief for an extended period of time will ever regain their courage and again become useful members of society.

*Extract from a radio address by John P. Hogan of the firm of Parsons, Klapp, Brinckerhoff & Douglas, and Chairman of the Public Works Committee of the American Society of Civil Engineers.

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LIMITED WAY WILL GIVE 81 PER CENT GREATER TRAFFIC FACILITY.—The "Limited Way," that is through highways with continuous grade separation, will provide motor cars in congested areas with the same facility of movement they now enjoy in rural districts. Such structures offer the only full and ultimate solution of the city traffic problem. Such is the opinion of Dr. Miller McClintock, director of the Albert Russell Erskin Traffic Bureau at Harvard University. "The Limited Way, properly constructed, will provide 81 per cent greater traffic facility than ordinary highways in congested areas," stated Dr. McClintock. "The tremendous saving of life, property and money produced by this safe acceleration of traffic is of unquestioned economic benefit and one which can be attained at less cost than ordinary street widening in many cases."

Survey of the Toll Bridge Field

By P. K. Schuyler

Secretary, American Toll Bridge Association

TOLL bridges, which have been increasing in number during recent years, render a service to the motoring public of considerable value. The rapid growth in the number and uses of motor vehicles has caused a sudden demand for transportation facilities to be created, and highway bridges have been the result of this demand in many cases. It appears advantageous and desirable upon first thought to have all these bridges constructed and operated free of tolls. However, upon further consideration it is probably advantageous that the larger and more expensive of these bridges be constructed and operated as toll structures, and by so doing, instead of the general public being taxed to construct the bridge, the tax is placed directly upon the user of the facility provided. Conditions with regard to motor transportation are rapidly changing and it is rather interesting to consider the history and development of toll bridges and their relation to the present system of motor transportation.

Toll bridges were constructed many years ago in Asia and the European Continent. The earliest record of toll bridges indicate that such structures were built in the Middle Ages by religious orders and for the use of the bridge a small fee was charged. It was believed that the order was doing a distinct service to the community by the construction of such bridges. Napoleon advocated a system of toll roads and toll bridges for France, which plan made considerable progress under his regime. In England a comprehensive system of turnpikes and toll bridges were constructed under the general turnpike act which was passed in 1663. By the year 1835 in Great Britain there had been constructed some 22,000 miles of turnpikes, and the construction of some of these roads were aided by government subsidies.

Among the first toll bridges in North America was the one that spanned the Newberry River at Rowley, Mass., which was built in 1654. By the end of the seventeenth century a toll bridge had been erected across what is now Spuyten Duyvil Creek at the northern end of Manhattan Island. In 1786 a toll bridge which crossed the Charles River from Boston to Charleston was opened to traffic. The financial success of the latter enterprise made other capitalists of that day anxious to embark in similar enterprises and 75 toll bridge charters were granted by the Massachusetts Legislature prior to 1870.

In 1787 Pennsylvania granted authority to build a toll bridge across the Conestaga Creek on the road from Philadelphia to Lancaster. A wooden bridge was constructed at this site which was later replaced by a stone bridge in 1800. It is reported that the toll receipts from this structure amounted to some $25 to $30 a day during the summer of 1818.

During the early days toll bridges played an important part in providing transportation service in New York State and by the year 1808 more than twenty companies had been incorporated to build and operate toll bridges.

With the exception of a few bridges which are located in or near large cities and relatively inexpensive structures on the most traveled highways, the toll bridges of the past cenutry seldom earned adequate returns on their invested capital. Travel was difficult and travelers were few and equestriennes or horse-drawn vehicles would oftentimes make use of fords or ferries, so as to avoid the payment of toll. The toll bridges themselves, which were largely constructed of wood, were often destroyed by floods or fire and had to be rebuilt frequently.

The motor vehicle, which came into general use during the early part of the present century, caused a radical change in the requirements of the public for transportation and necessitated the expenditure of large sums for the construction of adequate roads and bridges. These expenditures have been rapidly increasing until during the past year it is reported that over a billion dollars was expended by the states and counties in the construction of highways and bridges so as to provide adequate transportation facilities for the public.

A tabulation of a number of toll bridges and toll bridge projects in the United States or on the International boundary shows the following conditions:

	In Operation	Under Construction	Proposed
October 1, 1927.....	233	24	163
July 1, 1929.....	272	60	294
December 1, 1929.....	287	62	274
June 1, 1930.....	295	58	277
June 1, 1931.....	309	40	...
June 1, 1932.....	322	35	...

In this tabulation a toll bridge is considered to be proposed when such definite steps have been taken regarding it, such as obtaining or making application for a franchise or organizing a company. This table is rather interesting in that it illustrates that the number of toll bridges in operation is rapidly increasing, whereas most of us would believe this to be otherwise, due to the fact that the states and other public bodies have been purchasing and freeing the smaller of these bridges. However, the states are themselves undertaking the construction of toll structures.

The financing of toll bridge projects up to the year 1930 was carried out largely through the sale of securities by investment banking housse. Since this time, in common with the financing of other utilities, there has not been any activity in the flotation of toll bridge issues and hence the only toll bridge construction undertaken has been by the financing of such projects locally which has been relatively small. However, during this period there has been considerable activity in the financing of publicly owned toll bridges and a considerable number of states have continued to build such types of structures or have undertaken projects of this character. These states have in a number of instances issued revenue bonds secured solely by the income on individual toll bridges or groups of toll bridges. A considerable number of these state revenue bonds are not earning their interest and sinking fund requirements, and the public authorities are confronted with a problem on their hands.

The emergency relief and construction act passed by the federal government in June, 1932, authorizes the Reconstruction Finance Corporation to make loans to both public and private corporations for the construction of certain self-liquidating projects, naming in specific toll bridges. To date loans on this type of project have been made as follows:

Savana Sabula Bridge	$ 190,000
New Orleans Bridge	7,000,000
San Francisco Bay Bridge	62,000,000
Richmond Bridge	1,700,000
Catskill Bridge	3,400,000
Tampa Bridge	600,000
Total	$74,890,000

Improving LOW COST Bituminous Surfaces

By J. H. CONZELMAN

General Manager, Alabama Asphaltic Limestone Company

PUBLIC road officials must of necessity spend less money for road surfaces. On a large percentage of our road mileage funds are not available for anything but low cost types. On much of this mileage construction of anything more costly would be uneconomical for present traffic would utilize only a small fraction of the capacity of expensive, high type surfaces. To make the cheap surface really a low cost one, however, everything which reasonably can must be done to make them last as long as possible and keep maintenance costs down.

The use of a thin seal coat of cold laid fluxed asphaltic limestone on road-mix construction is a new development for low cost bituminous surfaces. Practically this development consists of placing a small amount of this bituminous paving mixture in the surface voids over the base course.

Coarse aggregate type road mix, or mixed-in-place, surfaces usually contain no aggregate finer than ¼-in.

Spreading the Fluxed Asphaltic Limestone Mixture Near Fayetteville, Tenn.

to ½-in. particles. They are, therefore, high void mixtures that must depend on a seal coat for protection against surface moisture. Surface moisture, if not kept out, would make ineffective the type of foundation on which these surfaces are laid. Penetration of moisture in the surface of a petroleum asphalt mixture would also result, in time, in breaking the bond between the aggregate and its bituminous coating, causing raveling and disintegration.

It seems evident that these high void bituminous surfaces should be sealed as thoroughly as possible from surface moisture. One way of doing this is with a fluxed asphaltic limestone, a fine graded mix, ranging in size from ⅜-in. to dust. This material makes a dense waterproofing covering.

Thin asphaltic limestone coverings have been used in Texas for years and surface treatment of this material has given very satisfactory service. These surface treatments are constructed by laying as little as 25 lb. per sq. yd. of fluxed rock asphalt as a cover on primed and bituminous treated gravel or similar base Briefly the fluxed asphaltic limestone seal coat is laid as follows:

On the work which has been done to date, specifications have called for the use of as low as sixteen (16) and as high as fifty (50) pounds of the mixture per square yard. As a rule thirty (30) pounds has been used. After the road-mix has been rolled and six to eight pounds of chips swept into the voids it is allowed to cure and toughen for a period of not less than three days. A seal coat of the same bituminous material used in the road mix is then applied at the rate of 0.08 to 0.2 gallons per square yard depending on the character of

Appearance of Rock Asphalt Seal Coat Immediately After Blading. Traffic Compaction Was Satisfactory

aggregate used in the road-mix and its need for additional bitumen. The fluxed asphaltic limestone mixture is then spread on the surface from trucks in small piles at the proper quantity to result in the desired spread per square yard. These small piles are windrowed with a rubber tired self propelled grader, either in the center of the road, if the width is great enough to take care of traffic on both sides of the windrow, or on one quarter of the pavement.

The windrows are then evenly distributed over the surface at the specified quantity per square yard by the rubber tired self propelled grader. A clapboard drag six to eight feet wide built of 2-in. by 8-in. planks is often

The Finished Surface a Few Days After Completion

used behind the grade to facilitate spreading the seal coat evenly and break up any lumps present. In spreading the seal coat best results are secured by wasting the mixture lightly on each trip, that is, by building up the thickness slowly as the mixture is carried by the blade back and forth across the road. One grader can spread from ¾ to 1 mile of seal coat per day.

As a rule the seal coat is not rolled.

The Relation of Money Wages to Per Capita Money for 90 Years

By HALBERT P. GILLETTE

BECAUSE every war-time inflation of currency has been accompanied by an even greater inflation in bank deposits, and because deposits are several fold greater than currency, it is usually inferred that wage and price inflations are caused mainly by inflations of bank loans and other credits. In order to determine the relative effect of increases in money and "credit currency" (in individual checking deposits) upon wages, I have prepared the accompanying table.

Reliable data for individual bank deposits in America are not available back of 1876, at which time they were $47.65 per capita. Mitchell, in his "Business Cycles," has shown that total "checking deposits" average about half of total individual deposits, so that for present purposes it will serve to compare individual deposits per capita with per capita money.

In 1926 the Treasury revised its method of estimating "currency in circulation." According to the old method of calculation the per capita currency in circulation June 30, 1919, was $55.67, whereas according to the new method it was $45.95. Obviously where a change in method of estimating currency in circulation can effect a difference of 20 per cent, it becomes impossible to contrast per capita circulation in early years with later years. Accordingly I have calculated the per capita money, as shown in the accompanying table, not upon the basis of money arbitrarily estimated to be "in circulation," but upon the basis of the entire stock of money in the United States, as of June 30, for each year. In 1840 it was $11.13 and in 1929 it was $70.28 per capita. Upon plotting this per capita money curve it was seen that it closely paralleled the wage index curve for 90 years, except during times of great booms or depressions. It was also seen that if the per capita money, to the nearest dollar, is multiplied by 2.7, as shown in the third column of the table, the product agrees remarkably well with the wage index. The greatest disagreement is in the year 1929 but in that year, and for several previous years farm wages were abnormally low. The wage index in the second column does not include farm wages, but if modified so as to include them it becomes about 200 instead of 233, and then a substantial agreement with 2.7 times per capita money is seen to exist. The table establishes beyond question the fact that the general trend of average wages in America has been the same as that of per capita money since the year 1840, which is as far back as reliable data exist.

The table also shows an entirely different trend as to per capita bank deposits, which, in 50 years became 10-fold, whereas per capita money became only 3-fold.

This disposes of the contention that increase in "credit money" is the primary cause of increase in money wages. On the contrary it evidently does not affect the trend of wages at all.

Thus far we have considered only long trends. If we turn to the oscillations that constitute a business cycle, we find that the velocity of circulation becomes the controlling factor. In measuring the relative velocity of circulation, I find that a very satisfactory meter is the ration found by dividing annual bank clearings outside of New York City by total individual deposits in banks at the middle of the same year. All departures of average wages from their general trend are quite accurately measured by the velocity of circulation thus deduced. Therefore we have this quantitative wage law:

The trend of average money wages is that of per capita money, modified by multiplying it by the velocity of circulation.

Based upon this law it becomes easy to deduce a commodity price law, which is:

Average commodity prices are proportional to average wages divided by the average output per worker.

I have tested this commodity price law back as far as 1869, which is the year of the first census that contains adequate data from which to compute the average output of factory workers. By applying a wholesale commodity price index to the total "value added by manufacture," it is feasible to determine the relative output of the average factory worker. The same can be done for the raw products of the mines and the farms, and a weighted average output can thus be deduced for farm, mine and factory workers. Thus deduced, the factor for the relative output per worker is divided into the wage index, and the quotient becomes the theoretical commodity price index. This theoretical index agrees so closely with the actual index that the commodity price law above given is seen to be a true law.

By dividing the "money wage" index by the commodity price index we get the "real wage" index. The result is very surprising, for in 1929 the average "real wage" in America was 4.5 times as great as in 1840. Yet the average working day was 11 hours long in 1840, as compared with 8 hours in 1929. Average "real wages" have kept pace with average increase in average annual output per worker.

The census of 1869 shows 33.1 per cent of our population engaged in gainful occupation, as compared with 39.8 per cent in 1929. Unfortunately only the last census shows the percentage of workers out of employment. In April, 1930, or about 6 months after the depression started, the census showed that 5 per cent of the workers who wanted jobs were unemployed. Hence it may be safely inferred that in normal times that percentage is not over 2 per cent. The inference is plain that the "machine age," now 150 years old, shows no trend toward unemployment.

The depression that started in 1873 witnessed a 15 per cent decrease in per capita money up to 1878, but by 1880 it was greater than in 1872 or 1873. The depression that started in 1893 witnessed a decrease of 15 per cent in per capita money up to 1896, but by 1898 per capita money was greater than ever before. Those two depressions most closely resemble the present one in severity and in time elapsed between the first crash and the lowest velocity of money circulation. Each of them had a total duration of about 5 years. Hence it is probable that within two or three years average money wages will be back nearly to the level of 1929. Commodity prices will likewise rebound from the levels of 1932.

In America per capita money has shown a strong tendency to follow the trend of per capita output of goods. The result has been that money wages have had an up-

ward trend except during depressions. This upward trend will probably be resumed when the present depression ends.

It should not be inferred from the wage and price laws that an inflation of currency during a business depression would cause a corresponding inflation in wages and prices. It might have the contrary effect by decreasing the velocity of circulation. The velocity of circulation is mainly influenced by the outlook for business profits. Currency inflation at the present time might alarm business men to an extent sufficient to cause increased business stagnation.

For a full discussion of the wage and price level laws, velocity of money circulation, etc., the reader is referred to Chapter II of my Handbook of Construction Cost, page 34 to 138.

TABLE SHOWING THAT AVERAGE WAGES HAVE THE SAME TREND AS PER CAPITA MONEY

Year	Wage Index	Per Capita Money × 2.7	Per Capita Bank Deposits
1840.....	33	30	....
1850.....	35	33	....
1860.....	39	38	....
1870.....	67	63	....
1880.....	60	64	$ 43
1890.....	69	72	65
1895.....	68	70	71
1900.....	73	84	95
1905.....	82	94	135
1910.....	93	102	166
1915.....	103	110	192
1920.....	234	207	353
1925.....	226	195	407
1929.....	233	190	438

FOOTNOTE: Per capita money is the total stock of money on June 30 divided by the total population. This is calculated to the nearest dollar per capita and multiplied by 2.7 which is the average ratio between the Wage Index and the per capita money. The Wage Index is that of the Department of Labor, the year 1913 being taken as 100. The wage index does not include farm labor; and farm wages had advanced far less during 1925 and 1929 than other classes of wages.

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Traffic Control in Wayne County, Michigan*

A careful traffic survey is made before erecting a signal. By this means we determine the economic losses caused by delay of traffic, the accident hazard at the intersection, and by any local conditions which might affect the public safety. With this information at hand it is necessary to make the best interpretation possible upon the advisability of a traffic signal. With so many intersections of important highways in Wayne County and with great fluctuations of traffic at these intersections, it is not always to the best advantage of the public that traffic signals be installed.

The ordinary traffic signal is built to operate upon a fixed-time cycle, and the phase, which is the amount of time allotted to each road, is set in accordance with the percentage of traffic on each road, as shown by a census made during the heaviest traffic hours of the day.

This method of timing works well enough where the traffic is light and fluctuation is not great. At such intersections in Wayne County, the signals are timed for 20 seconds of green light on each road, or where one road carries about 40 per cent more traffic than the other, 30 seconds of green on one and 20 seconds on the other. To allow more than 20 seconds causes a greater number of cars to stop at the intersection and less than 20 seconds does not allow cars enough space to go through on the green light.

Great difficulty is experienced at signalized intersections in adjusting the cycle and phase lengths to secure the maximum efficiency in passing traffic. Where fluctuation in density is great during a few hours of the day, we have added electric coils and time clock switches to the signal control to lengthen the phases and provide for the increase of traffic during these hours. This entails small expense and gives greater efficiency. However, on account of the complexity of equipment necessary, this type of signal is limited to around half a dozen such changes a day.

If, between the hours when these signals change, the density of traffic changes, traffic will be aggravated by unnecessarily long stops. The vehicle actuated signal which we are using at some intersections is much more flexible in this respect, in that the traffic running over a contactor in the pavement sets its own phase time.

Another desirable feature of these signals is that they warn of an approaching car on the cross-road just the same as a flashing railroad signal warns of the approach of a train to a crossing. When the light changes from green to red it indicates positively that there is a car approaching on the cross-road.

When two or more signalized intersections lie close together the signals are interconnected to let traffic move progressively through all of the intersections. This is accomplished by synchronous motors similar to an electrick clock in each control, or by inter-connecting all signal controls with a common electric wire. This type of signalizing is used only within the city limits of Detroit or other cities in the county, good examples being on Michigan Ave. in Dearborn and Northwestern Superhighway in Detroit.

At a number of locations in the county the "stop and go" traffic signals were removed and "stop" signs and flashing warning beacons put up in their places. This was done only after a careful study revealed that the change was to the advantage of traffic.

At one of these locations in one year there were ten accidents caused by cars on the north and south road running through the red light, and six accidents caused by cars on the east and west road running the red light. The visibility of the signal against a background of trees was poor in the north and south directions. By removing this signal and making the north and south road a "through" highway with illuminated "stop" sign on the cross-road the cause of ten accidents was eliminated. In five months since the change was made there has been only one minor accident at this intersection.

At others of these locations where there were no accidents, traffic surveys showed that the signal stopped and delayed more vehicles on the main road than the cross-road carried. The average delay per vehicle was ten seconds, whereas, if the main road were made a "through" highway and all traffic on the cross-road brought to a stop, the average delay for the cross-road vehicle was about five seconds. Obviously eliminating the "stop and go" signal and making the main road a "through" highway saved considerable delay to traffic.

*From the 26th (1932) annual report of the Board of County Road Commissioners of Wayne County, Michigan.

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TRAFFIC SURVEYS ON ARGENTINA HIGHWAYS.—The recently established National Highway Bureau in Argentina has decided to use a new scientific system of traffic counts, patterned after the American system, in analyzing the traffic preparatory to selecting the national and federal-aid provincial routes to be built under the new law. The Province of Santa Fe, one of the most thickly populated, has been selected by national and provincial authorities for beginning this important work.

Evaluation of EMULSIFIED ASPHALTS for Road Building Purposes

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RAPID extension of the use of asphalt in emulsified or dispersed form in the road building field has brought about problems of formulating specifications for such material by highway and road building engineers.

The use of emulsified asphalt as a binder in the low cost road field has met with favorable reception. Special attention to low cost roads has been stimulated by economic study, the desire to serve less heavily populated areas, and by the completion of heavy traffic road systems in many parts of the country.

The problem of manufacturing and defining suitable emulsified materials must be considered in the light of new types of road construction which have been successfully developed by engineers. Emulsified asphalt, suitable for one type of construction, may not be at all suited for another. It is to be expected that bituminous materials in dispersed form must be satisfactorily adapted for the intended use, much as with other bituminous binders, although from an engineering and technical point of view, the adaptability of emulsified asphalt entails problems peculiar to this type of material.

Construction types in which emulsified asphalt may be successfully employed, will vary widely from conventional and generally used penetration types, surface treatments and road-mix work, to the types of mechanically prepared plant mixtures with open and with standard graded aggregates. It is obvious that one type of emulsion will not serve all purposes.

While the more important manufacturers of emulsified asphalt have been successful in cooperating with engineers in producing the highest types of materials suitable for their special needs, the methods of defining, testing, and specifying the various grades of materials required, are open to much confusion. The lack of uniformity in various state specifications for the same type of use, results in great hardship to the manufacturer, as well as increased cost which must be passed on to the consumer. The significance of many of the specification tests is not yet fully developed, nor satisfactorily related to field practice. This is a natural consequence of the more rapidly developing uses, as compared with the more tedious development of testing technique.

It is the writer's purpose to discuss the properties required for road building emulsions and the significance of testing methods commonly employed to describe them, having in mind the best emulsified binder for a given requirement consistent with modern manufacturing and construction specifications.

Properties of Road Building Emulsions.—Without attempting to differentiate between grades of emulsified asphalt, it is evident that for satisfactory use, the requisite properties for successful road application must fall within the following general considerations. They must possess:

1. Homogeneity of dispersion:
   (a) Freedom from lumps and coarse particles.
2. Storage stability:
   (a) Maintain their dispersed state over substantial periods of time. Must not "break" or invert in storage.
   (b) Must remain suspendable—no substantial change in concentration of asphalt in the emulsion during storage in containers.
3. Capacity to be applied in the intended manner:
   (a) Proper viscosity or consistency limits.
   (b) Regulated chemical and mechanical stability or "break."
   (c) Homogeneity (Item 1).

in order to result in:

4. Capacity to deposit films of binder upon the aggregate of proper:
   (a) Quantity and coverage determined by % asphalt in emulsion and by viscosity of emulsion (3-a) in relation to its stability (3-b).
   (b) Quality of dehydrated bitumen.

The significance of these properties to road building requirements is in many instances self-evident. Difficulty, however, is encountered in certain cases, in prescribing various test methods for evaluating these properties. We will briefly discuss the foregoing requirements and the test methods available for their determination.

Homogeneity.—This term is strictly a misnomer as applied to emulsions, which are in fact heterogenious systems of immiscible liquids. As applied to asphalt emulsions which comprise asphalt particles distributed throughout an aqueous phase, it is intended that for practical purposes the emulsion should behave as a homogeneous liquid. This necessitates from the point of view of production and use, the preparation of an emulsion of uniformly fine particle size, so as to be free from clots, strings, or gobs of unemulsified asphalt, or of large size poorly dispersed asphaltic particles. Lack of homogeneity has its practical significance in impairing uniformity of distribution and in clogging of spray nozzles. The presence of substantial quantities of coarse particles (in excess of 10 mu), is frequently an indication that spontaneous and progressive breakdown is occurring and the storage stability of the material may become seriously impaired.

The methods of determining homogeneity range from simple visual inspection to quantitative measurement by screening through a standard size iron wire screen. The following method is satisfactory and frequently used:

SCREENING TEST

A convenient quantity of the emulsion (1,000 grams) shall be taken and passed through an iron wire screen having a mesh opening of .0394 in. (20 mesh) previously weighed and moistened with potassium oleate or sodium oleate of 2% concentration. The emulsion shall be poured rapidly through the sieve and a constant layer of emulsion shall be maintained upon it, and gently agitated with a glass rod which shall not be allowed to touch the screen

itself. When the emulsion shall have passed through, the screen shall be washed repeatedly with 2% soap solution until all the emulsion has been removed, and shall then be washed with distilled water until free from soap. The amount of deposit shall then be evaluated by drying the screen and contents to constant weight at a temperature not in excess of 250° F.

In addition to visual observations of homogeneity as to freedom from clotting, graininess, etc., the deposit upon the screen obtained in the above test should not exceed .15 per cent for satisfactory material.

Storage Stability.—Satisfactory emulsion must necessarily be stable to storage so that the material will not be subject to spontaneous decomposition between the time of manufacture and use. This decomposition in poorly prepared material may take place at a slow rate, or at a rate so rapid that partial or complete breakdown into separate phases, water and asphalt, occurs before the material can be used. In the latter case a mere simple visual inspection is sufficient and in the former case the screen test referred to above may be applied to determine whether the material is in a usable condition. The values given above should apply for satisfactory material which is to be used for spray application, although within limits material inferior in this respect may be utilized where mechanical mixing methods are employed.

Another phase of storage stability is comprehended by suspendability. While the type of stability just mentioned depends upon physico-chemical factors governing the dispersion system, suspendability is more definitely a physical phenomena.

Emulsion lacking in suspendability may segregate in containers to such a degree that asphalt is packed in the bottom of the container, and vigorous stirring is necessary in order to incorporate the asphaltic particles uniformly throughout the mass. Any such condition involving substantial segregation will result in variations in viscosity with consequent—

(1) serious mal-distribution of emulsion,

(2) non-uniformity of asphalt deposited on the road metal due to difference in fluidity and asphalt content.

It would be reasonable to suppose that the determination of suspendability would be simple. The method most generally in use involves the determination of the difference in asphalt content between the top and bottom of a 500 cc charge of emulsion standing in a glass cylinder 4.5 to 5 cm. in diameter for 10 days. While this involves a simple manipulation, it has a number of serious drawbacks which make it unsatisfactory for routine testing procedure.

In the first place, any test which requires 10 days for performance is impracticable from the point of view of the manufacturer, and likewise requires the consumer to hold his material for more than 10 days before the results of the test are known and the material released for use.

The test itself is faulty in that it does not measure the migration of the asphalt particles in the water phase, but is predominantly affected by syneresis occurring in small samples. This affects the quantitative result in a small container all out of proportion to any such phenomena, if occuring at all in a large container.

The analytical procedure is difficult of duplication and securing of check results, because of difficulty in removing the top layer by pipetting, the great influence of temperature upon the results, effect of syneresis which varies with age, agitation, and temperature conditions of setting up the sample.

Unfortunately, no entirely satisfactory method for evaluating suspendability of this type of material has been evolved which meets all objections. However, the best method to date for determining suspendability, which has come under the writer's observation, involves a modification of the foregoing method which greatly expedites results and obviates many of the objections recited above. The method is described as follows:

MODIFIED SEDIMENTATION TEST

500 ccs. of the asphalt emulsion shall be placed in a cylindrical glass container having an inside diameter of from 4 to 5 cms. It shall be provided with a stopper to prevent evaporation, and shall be allowed to stand for 5 days on a solid foundation free from vibration and at laboratory temperature (70-80° F.). If settling has occurred the top 450 ccs. shall then be siphoned out and the remaining 50 ccs. including all sediment, shall then be removed from the container. If observation indicates that the emulsion shows a tendency to cream, and the most concentrated asphalt portion is in the top layer, the top 50 ccs. shall be similarly removed. The sample taken from the bottom or top of the container shall then be tested for residue by "loss on heating," A. S. T. M. D6-30, except that the sample shall be heated in a 600 cc. beaker for 3 hours at a temperature of 325° F. The difference between the asphalt content of the original sample and that of the 50 ccs. removed from the bottom or top of the cylindrical container shall be calculated. Satisfactory material should show a difference of not more than 3.0% between the asphalt content of the emulsion and that of the most concentrated asphalt layer.

This method has the following advantages:

1. Halves the time for test.
2. Gives better check results.
3. Lessens amount of analytical work.
4. Measures actual migration of particles by obviating influence of syneresis and therefore
5. Accords more nearly with actual conditions of bulk material.

Some data may be here presented which illustrates the rate of migration of asphalt particles in well prepared emulsions. In this series of tests a number of samples were set up in standard cylinders for periods of time indicated and the asphalt content of all layers from top to bottom, determined.

MIGRATION OF ASPHALT IN EMULSION DURING SEDIMENTATION

	A	B	C	D	E
Days standing	12	12	12	20	14
Asphalt Content:	%	%	%	%	%
Top 50 cc.....	44.9	47.1	56.4	12.9	47.1
1st 100	62.6	61.1	61.2	60.2	62.1
2nd 100	63.7	60.9	61.3	62.4	62.5
3rd 100	63.3	61.4	62.0	62.8	62.2
4th 100	63.9	61.6	62.8	62.9	62.1
Bottom 50	64.2	61.6	62.7	62.9	62.2
Original asphalt content...	61.1	58.6	60.7	58.6	61.1
Difference: bottom-top.....	19.3	13.5	6.3	50.0	15.1
Difference: bottom-original	3.1	3.0	2.0	4.3	1.1

All samples showed distinct syneresis by more or less of a clear layer on the top 50 ccs.

It will be seen that actually the migration of asphalt particles in these materials is exceedingly slight, varying from practically nothing in sample E to a maximum in sample D. The presence of small amounts of clear liquid on the top of the test samples originating from syneresis, markedly and vitally influences the results predicted upon inclusion of such material in the top layer.

The fact that these materials which are representative of actual commercial shipments, show no sedimentation in practice, is confirmatory of the soundness of the proposed method of test.

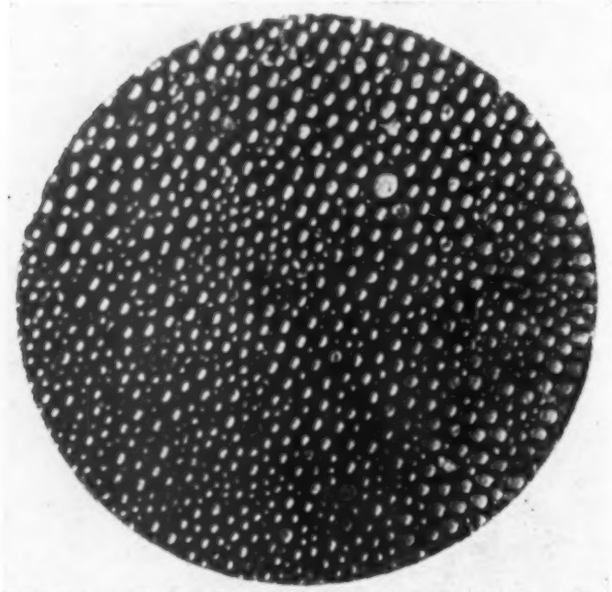
Values of the currently practiced method ranging from 6.3 per cent to 50.0 per cent apparent sedimentation give an entirely erroneous picture of the properties of these materials, theoretically, and in actual practice.

Some qualitative attempts in the laboratory to correlate the 10-day settlement test with actual observations are given in the following tabulations. In these experiments two series of 5 gallon cans, each series of

6, of different emulsions were set up and observed for 50 days while samples of each were subjected to the 10-day settling test with the following results:

CORRELATION OF SEDIMENTATION TESTS WITH STORAGE OBSERVATIONS

	SERIES E			SERIES D		
	Settling Test—10 Days Difference in Asphalt Content Cylinders		Condition of 5 Gal. Can 50 Days	Settling Test—10 Days Difference in Asphalt Content Cylinders		Condition of 5 Gal. Can 50 Days
	Bottom Less Top %	Bottom Less* Original %		Bottom Less Top %	Bottom Less* Original %	
1	3.5	5.5	Perceptibly Thicker Portion About 2" at bottom	3.3	2.3	Perceptibly Thicker Portion About 4" at bottom
2	4.5	6.9	About 2" at bottom	3.4	3.2	About 4" at bottom
3	12.3	5.9	About 3" at bottom	4.0	2.7	About 2" at bottom
4	39.3	4.1	About 2" at bottom	5.0	1.7	About 3" at bottom
5	43.8	3.6	About 2" at bottom	6.2	2.0	About 4" at bottom
6	48.5	2.1	About 3" at bottom	7.5	5.5	About 4" at bottom
Asphalt content of all original samples..		55.3		...	58.4	



Micro-photograph of Drop of Emulsion

Series E especially shows total absence of relation to samples in storage. Nothing of the substantial variation in the conventional settling test is reflected in the condition of the samples. There is an insignificant variation in the container samples which accords more closely with the proposed test in which the value represents the difference between the original asphalt content and that of the bottom 50 ccs. Quantitative examination of containers must be made to establish a more exact correlation with the proposed test, but even the qualitative results show the incorrectness of the current method.

Capacity to Be Applied in the Intended Manner.—This invites consideration of the adaptability of the material for use as by spray application for penetration, surface treatment, and road-mix work. Asphalt emulsions change their viscosity but little with temperature changes, in contradistinction to hot applied bitumens and cutbacks. Being applied without heat, there is no practical means of modifying the spraying characteristics of such a material on the job, as is the case with hot applied bitumens. It is necessary, for this reason, and for others to be hereinafter discussed, to have the emulsion reach the work at a consistency at which it can be properly sprayed. This does not mean that safety lies in the most watery and easily applied liquid, for that invites use of material which is uncontrollable and which will run off the surface to which it is applied. This is one of the most common causes of failure in the use of emulsified asphalt.

Consistency which is suitable for spray application is seldom suited for plant mixed work or for treatment of aggregate such as by the immersion process. In fact, each type of construction is best served by material within definite consistency limits. This is a feature in which specifications are generally silent—a matter which seems illogical in view of the care which is taken to regulate and proscribe the consistency of most bituminous road building materials. Further and vital influence of viscosity will be discussed in a later connection.

Viscosity determination may be made by various types of efflux instruments, of which possibly the Saybolt-Furol viscosimeter is most generally adapted. An instrument such as the Gardiner Mobilometer is likewise a convenient one for these determinations and perhaps offers a wider range of observations. For heavy and mixing emulsions, the ordinary efflux instruments are not well adapted.

Practical experience has shown viscosity limits within which various types of material should be properly applied. For example, for penetration work with quick-breaking emulsion, Saybolt-Furol limits between 20 and 50 have proven entirely satisfactory, both from the point of view of distribution and coverage. Likewise, with the more stable material required for road-mix work, 25-75 Saybolt-Furol appears to present the most desirable values.

Mechanical Stability and "Break"—Regulation of this property is a most important one. It is, of course, desirable that an emulsion be produced to "break" within the shortest time compatible with the conditions of its use. It must, however, not be so unstable that there is danger of spontaneous break occurring in storage, or before the material can be properly placed on the aggregate in the road. For example, an emulsion of the quick-breaking type should not be so unstable that it breaks during the surface treatment, before aggregate can be applied and too late for the water phase to be still capable of wetting the aggregate. A proper degree of stability enables the stone to be placed while the emulsion film contains its water and is of maximum thickness, and further utilizes the wetting properties of the emulsion which enables it to "creep" up the stone cover. On the other hand, in deep penetration work, too highly stabilized material, inducing delayed cure, is undesirable, while such material must necessarily be sufficiently stable if intended for mechanical admixture with aggregates containing variable amounts of fines. Obviously emulsions for the latter purpose which must be stable to small quantities of electrolytes and to oppositely charged particles, must have a different degree of stability than material to be used in penetration work or surface treatment.

The general problem is complicated by the fact that temperature and humidity conditions during application materially affect the performance of the material on the

*In these particular tests, the modified method was prolonged for 10 days instead of 5 days in order to show comparison with the current method over the same period of time.

road. Such influence may be more effective in varying the time of break than any predetermined degree of stability imparted to the emulsion. Despite this, all other conditions being the same, it is desirable so to produce the emulsion that for respective types of construction it possesses the maximum rate of break compatible with conditions of its use, and within the range of drying conditions which may be encountered in practice. Obviously this must permit of reasonable latitude and invites no hair line specification standards if reasonable performance is to be expected.

A variety of methods of evaluating the rate of "break" of emulsified asphalts have been proposed and may be referred to here briefly.

Stability Test.—This method has been used abroad. It is predicated upon the determination of water content of a sample when inversion occurs upon the removal of water by heat and agitation. Fast breaking emulsions invert with highest water content, whereas the water may be removed to a larger extent from the more stable emulsions before inversion occurs. The method is carried out as follows:

Approximately one gram of emulsion is placed in a porcelain crucible (1 in. to 1¼ in. diameter) and concentrated by stirring under an air current at 18° C. 20° of such velocity that the initial coagulation point is reached after ½ to ¾ hour. By means of small blower rotating slowly, a convenient air current may be produced which is projected into the crucible through a 4-5 mms. jet. It has been found that under normal humidity conditions the air need not be dried.

Stirring should be gentle but continuous to avoid any skinning-over of the emulsion, and should be done in such a way as to avoid coating the sides of the crucible with a thin film of emulsion.

Concentration is carried on until coagulation of the bitumen begins on shearing the emulsion, at which point the bulk of the material is transferred to a weighed dish and the residual water-content determined by evaporation at 110° C.

The water-contents to be expected for various types of emulsion are as follows:

Unstable emulsions (fast)	15%-25%
Semi-stable emulsions (medium)	8%-10%
Stable emulsions (slow)	5%- 8%

Note: For the purpose of this test the loss on heating at 110° C. may be taken as the water-content of the emulsion.

This method is said accurately to distinguish between fast and slow breaking emulsions, but has not been investigated in the light of present practice in the United States.

Filter Paper Break.—This method depends upon the capillary removal of water by a standard filter paper and the measurement of time required for the aqueous phase to traverse a specified distance from the test area. In detail it is described as follows:

The rate of break is made on a piece of Whatman No. 4 paper on which is stamped two concentric circles 4.0 cms. and 2.8 cms. in diameter. The filter paper is laid horizontally and so placed that the area under the two circles is not impinging on any surface. This may be accomplished by placing the filter paper on a convenient ring stand. The inner circle is completely filled with about 2 c.c. of emulsion as quickly as possible by means of a small glass dropper. The water from the emulsion is absorbed by the filter paper, and the time required for the water to spread from the inner ring until it generally reaches the outer ring is timed with a stop watch and recorded as the Rate of Break. The average of 3 to 5 determinations should be recorded.

Values of 40 to 100 seconds are reasonably descriptive of fast breaking emulsions of relatively low viscosity. The method is not so applicable to evaluating slow breaking types of higher viscosity and lower water content (28-35 per cent). It has the further drawback of being affected by the character and uniformity of filter paper used.

McKesson Test.—This method most nearly parallels the behavior of material as it may be used in the road.* It has serious shortcomings, however, from the point of view of laboratory technique, in that it requires for accuracy a constant temperature, constant humidity oven and the use of the same aggregate which is not available as a standard in different laboratories. Further, the results are vitally affected by variations of viscosity in the same material so that it measures not the inherent "break" of the material itself, but its stability as affected by film thickness. It is of considerable value as a test for comparing the performance of various materials under comparable conditions with another material of known behavior, but as at present carried out it is not well adapted for specification or control test requirements.

Stone Mixing Test.—This test is described and standardized as A. S. T. M. D 244-28T. It represents a satisfactory and practical visual means of differentiating between fast and slow breaking emulsions. It is incapable of differentiation within either type and has the disadvantage of requiring a standard aggregate making comparison between different laboratories difficult. Further, the results of the test cannot be given a mathematical value.

Modification of this test to include a certain percentage of fines (50 to 200 mesh) with the larger aggregate, makes it possible to differentiate in stability between emulsions intended for mixture with clean stone and with graded aggregates containing such fines.

Calcium Chloride Test.—This method has been recently developed and proposed by Mr. J. E. Myers, chief chemist of New York State Highway Department Laboratories. It has been quite widely adapted in state specifications and represents a test method which is free from many of the objections found in the other methods proposed for evaluating break. It, however, has other limitations which are hereafter discussed.

The method depends upon the titration of the test material with calcium chloride of standard normality and needs no description here.

Obviously this is a test for chemical stability and the values will be greatly influenced by the quantity and type of stabilizer used, as well as by the presence of other reacting electrolytes in the emulsion. It is frequently assumed that the chemical stability so evaluated is related to the mechanical stability of the material in the road and its rate of break while subject to evaporation of the aqueous phase. While there may be such fairly definite relationship in emulsion produced in the same way and from the same constituents, it is unsafe to make such generalization as applied to emulsion materials of different origin, and certainly no sharp lines of distinction can be predicated upon the information as yet available.

Attempts to correlate emulsions of considerable range of calcium chloride value with actual performance in the field, have given negative results.

The following field tests are reported from the laboratories of the Shell Oil Co. of California in which various commercial emulsions having the hereafter indicated calcium chloride rate of break, were applied to the road upon the same day and in adjacent areas. The aggregate consisted of ½-in. to ¼-in stone in 6-in. layers and each emulsion was applied at the rate of 1½ gallons per square yard in small adjoining areas so as to avoid any possibility of the results being influenced by different weather conditions.

*McKesson, Proceedings A. S. T. M., Vol. 31, page 841, 1931.

From time to time the penerated layers were dug into for the purpose of ascertaining the time at which the aggregate at a depth of 2 in. became black.

These experiments were carried out on a clear, warm day, and the observations were as follows:

RELATION BETWEEN CALCIUM CHLORIDE TEST AND BREAK UPON THE ROAD

	No. 4	No. 5	No. 7	No. 6	No. 2	No. 8	No. 3	No. 1
% Asphalt....	52.0	57.2	56.0	56.5	56.8	52.4	55.2	53.6
Viscosity Saybolt at 77° F.	14.5	27.0	19.5	27.0	38.0	21.0	33.0	25.0
Pen. at 77° F. of Asphalt..	190	161	155	155	170	144	220	220
% Soap in emulsion....	.45	.52	.55	.38	.30	.29	.29	.28
$CaCl_2$—35 cc. .02N	31%	34%	52%	58%	67%	69%	93%	96%
Breaking time on road., min.	141	138	157	205	146	65	148	148

The determination of breaking time was of course subject to such experimental variation as would naturally occur in connection with an observation of this kind, but it is believed to be accurate within practically determinable limits.

The general conclusions from these tests would be that such differences in calcium chloride as are here noted, do not reflect themselves in any decided difference in breaking time in practical application.

On the following day, which is described as being cool and cloudy, samples No. 5 and No. 6 were again applied, with recorded break in the road of 345 minutes for No. 5 and 350 minutes for No. 6. This trial was made to compare the influence of difference in weather conditions prevailing during the two days, and indicates quite clearly the effect of atmospheric conditions on the rate of break and its effect as compared with the calcium chloride characteristics of the emulsion.

These data show no consistent relation in performance upon the road between emulsions ranging from 31 per cent to 96 per cent calcium chloride value. No. 1, which has the highest calcium chloride test, breaks in practically the same period of time at No. 4, the lowest.

The calcium chloride test using 35 cc N/50 solution, undoubtedly distinguishes generally but not infallibly, between "fast" and "slow-breaking" emulsions. As a measure of performance in break within the fast-breaking type (above 30 per cent demulsibility) it is seriously questioned whether there is any practically distinguishable correlation. Specification requirements should therefore not attempt to do more than set a reasonable minimum to distinguish this type of material from the slow-breaking variety. A minimum of 30-40 per cent demulsibility under this test suffices for all practical purposes. The tendency to specify higher values on the theory that the higher the requirement, the faster the break on the road, serves no needful purpose and may result in production of inferior material from the point of other considerations.

A variation of the calcium chloride test has been proposed which is directed to distinguishing differences within the slow-breaking ranges of emulsions. This comprises the titration of the emulsion with 50 ccs. of N/10 $CaCl_2$ and the determination of percentage of agglomerated asphalt. Here there has been little opportunity to determine the signficance of the test as related to field behavior, and instances have come to the writer's attention where actual differences in stability as evidenced by stone mixing tests, fail to be distinguishable by the N/10 $CaCl_2$.

To four hundred and thirty-five grams of No. 1 dry trap rock (½ in. to ¼ in.) are added 25 grams of dry trap rock fines produced by crushing the coarse rock (through 50 on 200 mesh). Forty grams of the emulsion to be tested are added to this previously mixed aggregate and the whole mixed thoroughly for three minutes in a suitable container. After mixing the composition shall be allowed to dry. The emulsion shall coat the aggregate with a uniform film in a wet condition and show no sign of stripping or formation of lumps, and upon drying shall show a substantially uniform distribution of the deposited asphalt over the aggregate.

For the slow-breaking emulsions, the use of N/50 $CaCl_2$ seems to be sufficient for a general segregation as to stability and if combined with the above modified standard stone mixing test, it is believed to afford a basis for distinguishing several types of specification materials.

The following would represent values which may be set for this purpose:

	35 cc. N/50 $CaCl_2$	Stone Mixing Test	Stone Mixing Test with Fines
Quick breaking emulsion for penetration and surface dressing	Not less than 30%	No .	No
Medium breaking emulsion (low asphalt content) for pre-mix with clean aggregate	Not more than 15%	Yes	No
Slow breaking emulsion (high asphalt content) for cold patch with clean aggregate	Not more than 5%	Yes	No
Slow breaking emulsion for road-mix work.....	Not more than 5%	Yes	Yes

Much remains to be done in the study and development of methods of evaluating "break."

Deposition of Bitumen Film on Aggregate.—Our previous discussion has been directed to properties of emulsions relating to application conditions for the intended use of the emulsion. Many of these properties discussed have a controlling significance in relation to the distribution and amount of binder deposited upon the aggregate.

In order to effect distribution of the emulsion, it is necessary that it have the proper fluidity or viscosity. Material which is too thin may cover inadequately or drain to the bottom of a penetrating course without leaving the necessary bituminous coating. Conversely, material too viscous may be lacking in penetrating properties or may not distribute itself sufficiently freely by "creeping" or otherwise.

It is desirable to have a consistency for this type of work which permits the emulsion to "creep" or travel about the individual stones and wet the under side thereof, much as a free-flowing aqueous liquid.

The deposition of the required film is not solely dependent upon the viscosity, but also upon its relation to stability or break. Thus, it is apparent, that other things being the same, a less fluid emulsion given sufficient time with a slower break may cover satisfactorily. A thinner emulsion must have a faster break in order to retain sufficient bitumen on the stone upon contact. The use of a thin emulsion of too fast a break may result in depositing its bitumen so rapidly on the stone as to impair its proper travel through the road metal and result in improper coverage. On the other hand, too fluid emulsion having too slow "break" will drain off the aggregate like water, depositing insufficient film thickness. These properties of viscosity and stability should be so related as to ensure, with the necessary asphalt content, optimum coverage, and a film thickness which

yields the necessary percentage of bitumen to bind the road metal together.

Specifications must call for a minimum asphalt content not only for economic reasons, but in order to achieve the above result. It is frequently supposed that control of asphalt content insures a control of viscosity. This is incorrect except as applied to dilution of a given emulsion. Two different asphalts made into emulsion of the same composition, may have widely varying viscosities. Even the same emulsion system itself can vary substantially with the method of preparation.

Low bitumen and very fluid emulsions may require an unnecessary number of applications. There is no point to limiting the maximum asphalt content provided the consistency is specified within limits which provide suitably fluid material for use. In fact, for many purposes, within the specified range of fluidity, the more asphalt, the better. The upper limits of asphalt content are, therefore, not justified in specifications.

Quality of Deposited Film.—This is dependent upon the character of the asphalt used, and we believe warrants some discussion here to set out the essential consistency differences between asphalts suitable for emulsions as compared to hot applied asphalts. Because the very nature of an emulsion makes possible the depositing of a very thin asphalt film on the aggregate and the further fact that good design does not contemplate the use of the deposited asphalt in penetration types as a void filler, the proven practice dictates the use of asphalts in emulsions having much higher relative penetrations than those used for similar hot applied types. It is quite in order to manufacture emulsion from asphalt having 150 to 200 penetration or even softer, for use in penetration work where normally an 85-100 penetration asphalt would be used if it were applied hot. Generally, softer binders should be employed in various analogous types of construction, the differences diminishing, however, in proportion as the construction type depends less for its stability upon the mechanical stability of the aggregate.

These high penetration, ductile asphalts as used in emulsions are not inclined to produce bleeding or shoving as would be expected if used in an unemulsified form, because of the lower asphalt content possible to achieve in the aggregate.

Having in mind this point, current specifications generally carry sufficient descriptive requirements to provide the use of satisfactory binder.

Inasmuch as no tests can be directly performed upon the film deposited from the emulsions the quality of the asphalt must be determined with the residue recovered by distillation or evaporation of the water.

Methods employed for recovery of the bitumen from the emulsion are not entirely satisfactory in that the bitumen is recovered in an altered form and tests upon distillation residues must recognize this fact. Distillation methods are likewise awkward from a laboratory point of view and sometimes must be prolonged and carefully attended in order to avoid foaming. These shortcomings are recognized by various organizations and better methods of recovery of bitumen from the emulsion are in process of formulation.

It is apparent that there remains much to be done in the development of proper testing technique for various types of emulsions. The problem is not simple and it must necessarily follow the production and determination of various types of materials which are found suited to field manipulation and service.

It is hoped that specifications and test technique will be developed on a sound basis so as actually to reflect standards related to field requirements.

New Toll Bridges Proposed at Grand Island, N. Y.

The Reconstruction Finance Corporation on March 31 agreed to purchase $2,800,000 revenue bonds, bearing interest at the rate of 4½ per cent, of the Niagara Frontier Bridge Commission, the money to be used to construct two toll bridges over the east branch of the Niagara river on a new proposed highway from Niagara Falls to Buffalo, New York.

The commission was created by an act of the legislature of the state of New York taking effect in April, 1929.

The loan was approved by the R. F. C. board subject to a number of conditions which will be worked out at a later date.

The structures, monumental in character, will be known as the North Grand Island bridge and South Grand Island bridge. The superstructure of the North bridge will be 4,100 ft. in length; South bridge, 2,000 ft. The approaches for each will be about 1,650 ft. each in length. The roadway of each will be 24 ft. wide with two 3-ft. sidewalks.

Approximately 50,000 cu. yd. of concrete will be required in the bridge structures, approaches and embankments and plazas; 1,500 tons of reinforcing steel; 12,550 tons of steel; 44,500 ft. of concrete piles.

The main channel span of the South bridge will be 600 ft.; the North bridge, 500 ft.

The total cost of the two bridges is estimated at $4,000,000. A preliminary schedule of tolls has been set at 10 ct. for passenger cars, including passengers; 50 ct. for trucks; 50 ct. for buses. Traffic on the proposed highway and bridges is expected to be increased due to development of parks by the State Council of Parks, on Grand Island. The two bridges will connect state parks at each end of the island. Considerable work has already been done, it is said, in developing the Grand Island park through hiring of men from the ranks of the unemployed. Considerable relief monies, available for materials and labor in connection with further development of the island, will be released as quickly as work on the bridges progresses.

The state of New York will construct a 6-mile highway on Grand Island as a connecting roadway between the two bridges.

It is estimated that 2,000 men will be employed 18 months on the project on the basis of a 30-hour work week.

Gas Tax Diversions Are National Danger, Warns Chief MacDonald

In commenting upon the tendency of state legislatures to divert gas and other special motor taxes from highway purposes during 1933, Thomas H. MacDonald, Chief of the U. S. Bureau of Public Roads, said a few days ago:

"Such contemplated reductions are serious enough to endanger both our large capital investments in highway construction and the technical organizations of our highway departments. These organizations must be protected to hold what progress we have made. Our whole improved road mileage is absolutely dependent for its existence upon the day by day highly organized maintenance operations under experienced supervision and control.

"This is a nationally vital concern; it is impossible to overstress the hazard to the public's interests in any breakdown of maintenance and technical control by highway departments."

Fig. 1

Rough Grading on a Rocky Road

By CHARLES T. FISHER

Engineer, Owen P. Williams Construction Co., Inc., Oneonta, N. Y.

Fig. 2

DURING the construction season of 1932 a job in southeastern New York has furnished a few variations from the usual routine of roadbuilding. Lying in the hills along the Delaware River, and running for several miles of its length far away from highways or

Fig. 3

habitations, through country where even soil is scarce, its location has features which are unique.

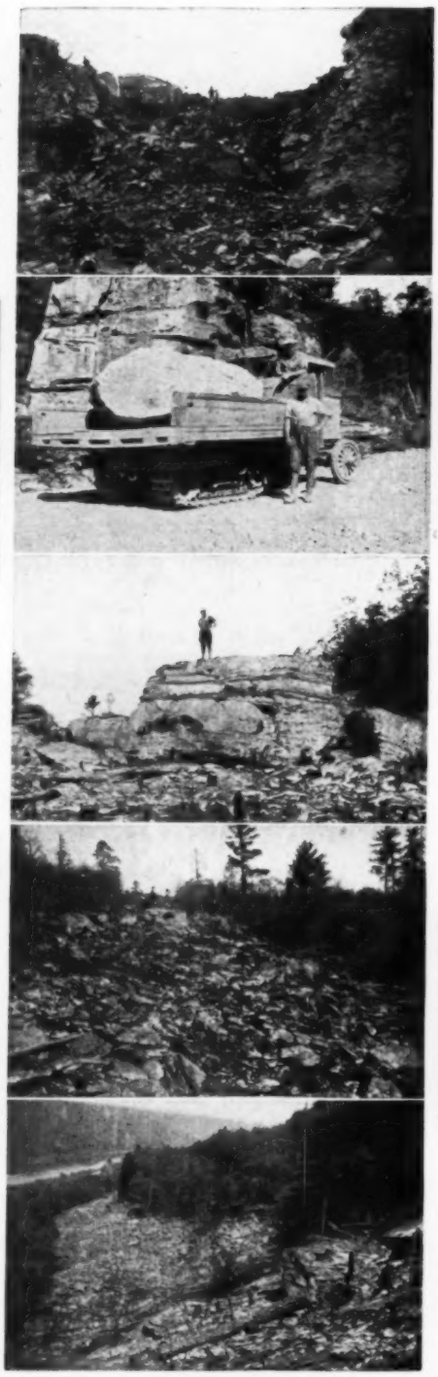
Scorning the simplicity of a valley route, the new road climbs a 10 per cent grade to a high summit which affords a beautiful view of the river

Fig. 4

Fig. 5

(Fig. 1). To reach this point, a fill of some 50 ft. above center line is necessary (Fig. 2), but material enough for this big fill and enough waste to build another one like it comes from the 65 ft. summit cut, which is 1700 ft. long and contains 137,000 cu. yd., principally rock.

An unusual feature of this cut will be the cutting of 1 to 1 side slopes



Rock, Rock and Still More Rock. Cuts Numbered from Top: Figs. 7, 8, 9, 10 and 11

through solid rock, specified in order to let daylight get to the bottom so that traffic may proceed in safety (Fig. 3).

A well-drill (Fig. 4) is used for the deep blast holes. A 4 in. by 16 in. stick of dynamite still needs a little

Fig. 6

tamping after it is dropped down a 60 ft. hole (Fig. 5).

The head of the cut just before firing three well-drill holes is shown in Fig. 6, and the result of the shot is shown in Fig. 7.

Linn tractors equipped with special timber bodies (Fig. 8), devel-

Fig. 12

oped and built on the job by the master mechanic, Jay Manwarren, are used for hauling rock. Rock occurs on the surface as well as beneath it (Figs. 9 and 10). Figure 11 shows the site of the big fill shown in Fig. 2.

In the "Big Rock Cut" work has been carried on in two 10-hour shifts. A generator driven by a 60 h.p. gasoline engine furnished power for electric lights, enough of which were

Fig. 13

strung along the work to make the operation of the shovel and Linns safe at night, when it really is dark down in that cut.

One of the lights, suspended from

Fig. 14

a pole at the top of the cut, revealed that a profile of the Goddess of Liberty had been blasted out of the rock.

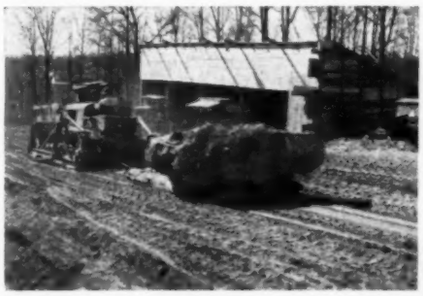


Fig. 15

There are also some good sized dirt cuts on the job (Fig. 12), but there are plenty of "plums" (Fig. 13) in them, which are disposed of by loading on 3-way dump Linns (Fig. 14) or by hauling them away on a log "boat" pulled by a bulldozer (Fig. 15) or back of a Linn (Fig. 16).

Five shovel outfits have been in use on the job. Gasoline has been delivered to each machine daily by a tank truck (shown in Fig. 4), but

Fig. 16

oil and grease are kept in portable oil houses which move along with the outfit (Fig. 17).

Sand and stone for concrete structures are imported, and expensive.

Fig. 17

Some saving has been made in building the small culverts by using timber bins, on skids (Fig. 18) which could be dragged along the grade, for holding the materials.

Plenty of timber is available from

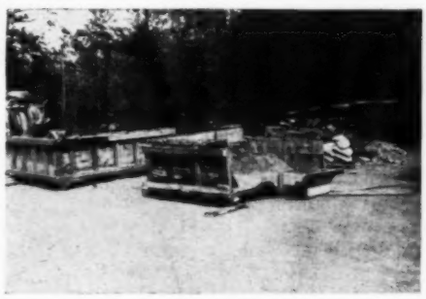


Fig. 18

Fig. 19

the right-of-way. When lumber is needed for buildings or other purposes a few logs are rolled on a truck and taken to the nearest mill (Fig. 19).

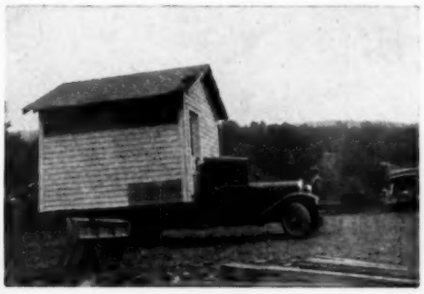


Fig. 20

Figure 20 shows the state engineer's office arriving at a new location.

Fig. 27

Certain forms of wild life were plentiful in warm weather (Figs. 21, 22, 23, 24, 25, 26). Some of them had fine sets of rattles.

This contract is still to be completed, and many things can happen before the maintenance men put up their sign (Fig. 27).

Some By-Products of the Job Are Shown in Figs. 21, 22, 23, 24, 25, 26

RESEARCH on Fillers for Brick Pavements

By JOHN S. CRANDELL
Professor of Civil Engineering, University of Illinois

The word "research" has come into prominence during the past ten years or so. It is one of those words that has a glamorous romanticism to it. The hearer immediately conjures up a man with a Van Dyck beard, eye glasses, a white smock, a microscope, a note book crammed with data, shelves filled with test tubes, delicate balances under glass covers, and similar paraphernalia that our national advertisers and movie directors have invested the business with. Maybe there are such men moving through scenes such as the cinemas invent, but those of us who are doing any investigations in engineering projects are never seen thus.

RESEARCH investigations of one kind or another on brick pavements have been going on for years, but it is only recently that we have collected our facts and put them in such shape that they are available to everyone, although all may not interpret them similarly.

When first I went into highway work about 25 years ago there was a war on between the cement interests and the bituminous interests concerning the sort of filler that should be used in brick pavements. That war is still on and will continue until long after suitable research has decided the problem, for you can't keep a good salesman down. In the meantime some of us who are only innocent investigators are trying to discover the truth about the many fillers that are offered for sale. We are not interested in any sales arguments, in any extravagant claims for goods, in any fancied superiority of one brand over another. We are interested in facts.

Starting Research.—How do we begin an investigation? Usually it happens that somebody somewhere has noticed that something is right or wrong with a brick pavement. He tells George Schlesinger what he has noticed, and Mr. Schlesinger writes me a letter giving me the facts as ascertained in the field from observations, the name and address of the informant, and any other infromation that he may have unearthed. I then try to obtain samples of the materials to be investigated. Or I try to duplicate materials and conditions.

About six years ago the question of mastic cushion courses for brick pavements needed an answer. I had been made chairman of a committee of the Highway Research Board to study the matter. I got together with Mr. Schlesinger of the National Paving Brick Association, Mr. Prevost Hubbard of the Asphalt Institute, Mr. Geo. E. Martin of The Barrett Co., Mr. Pollock of the Granite Paving Block Association, and several other well known road men. We talked over the materials and their several uses, and suggestions were offered as to what was wanted in practice for different classes of paving. The first thing we did was to examine similar work that had already been done, get samples of the cushions from such pavements, analyze them for bitumen content, characteristics of the sand itself, examine the pavements, and obtain information from the engineers in charge of the work when it was done, and subsequently. Then we made up samples in the laboratory, using many different bituminous materials, in many combinations, with sands of different qualities. These samples were then exposed to laboratory-made weather. By this I mean that the samples were exposed to dry and to damp conditions, to freezing and to thawing temperatures, and to all reasonable combinations of these. Time was a factor that was carefully taken account of. Some of the samples that were good at first proved to be poor after the passage of several months. Progress reports were made at the annual meetings of the Highways Research Board. Meanwhile field investigations were made. Some of the materials that were most strongly advocated by manufacturers were found in the laboratory to be of doubtful value. Would they act likewise in the field? As a matter of fact every sample so far tested in the laboratory has given the same results on the job. We have usually obtained our laboratory information in advance of that from the highways themselves, and it has been highly encouraging to have had the highway and laboratory reports check.

In one case we found, a year in advance of the manufacturer, how his materials should and should not be used. Had this concern made use of the information thus furnished through the Highway Research Board it would have been saved money and time, and would have made friends for itself. Instead of which it endeavored to promote a material for uses that were at variance with its characteristics.

Our laboratory study of mastic cushion courses taught us as much in a few months as we could have learned in the field in a number of years. By devising "hurry-up" tests we can duplicate in a short time what would normally take years to show up in practice. Recently we wanted to find out how well whitewash stands the weather. And then we wanted to prove the claims of

some manufacturers who say that their products will improve whitewash. We made up some pieces of brick pavement, whitewashed them on the surface, and put them in an artificial rainstorm for a week. The damp-room was so arranged that we were able to have a nice gentle rain, a hard driving rain, a sleet storm, a deluge, or a mist. After exposing the sample pavements to all of these, and after trying all of the various mixtures and admixtures that had been suggested, we were able to show that plain old ordinary whitewash of a certain consistency is better than that which has been doped up with other ingredients. We did show, though, and very decidedly, too, that only a well mixed whitewash of certain definite proportions would stand the weather.

Penetration Depth.—Do plain wire cut bricks prevent bituminous or cement grout fillers from flowing into the joints? How many times have you wondered whether or not the filler was running to the bottom of the joint, and how could you prove it was or it wasn't without disturbing the pavement unduly? That was a question that bothered us last year. It was answered very clearly by a simple device that one of our men thought up and put to use. He laid a stretch of pavement in the laboratory and substituted plate glass for the last row of bricks. Now all you have to do is to look through the glass side of the pavement to see the filler in action. We found that the lug block allows plenty of filler to flow into the joints, but the lugless brick keeps it out.

A foreign manufacturer who would like to break into American business sent a sample of joint filler which he claimed was somewhat superior to anything else on the market. He also claimed that it is a rubber compound. We put it through some laboratory tests and within a month were able to tell accurately its value to the paving brick industry. It lost its quality of adhesion, it became brittle at freezing temperatures, and it had no rubber content at all! Without this research it would have been necessary to try out some of the material in a pavement and to watch it for a year or so. Undoubtedly that sort of test is excellent, and I do not know of any method that so surely tells you the answer, but it takes a long time, and usually there is a considerable amount of money involved.

Temperature plays such an important part in the life of a pavement that we have to abandon certain types because they will not stand up under the extremes of summer and winter that most of our American roads are subject to. Although bricks are proof against extremes of temperature, yet many a brick pavement has failed because the filler in the joints has been unsuited to the climate. A cement grout filler may make the pavement blow up, and some of the bituminous fillers may flow out of the joints leaving the bricks unsupported and loose. Research reveals the defects and offers remedies. By making a careful study of those pavements that have stood the test of time and traffic we may come to some rather definite conclusions concerning the proper methods of construction, the suitable materials, and the necessary engineering skill that entered into the job. By making similar studies of unsatisfactory pavements we may learn, if we will, why they failed. By subjecting the materials of construction to laboratory tests we may increase our knowledge of pavements, and we may be able to predict what the practical result will be, if we are dealing with untried goods. Many bituminous fillers have the unfortunate quality of flowing when the summer sun is very hot. If the pavement has a high crown then you will find that the filler has left the highest part and has flowed to the edges. Sometimes, on city streets, there will be veritable bituminous lakes along the curbs, whereas the center line of the pavement is without any filler whatsoever. The bricks near the center either are loose, or the joints become filled with filth. Several schemes have been proposed to do away with this trouble. The mastic filler was an early development, and there is no doubt that the addition of sand to the bitumen tends to stiffen it and hold it in place. But when you attempt to mix sand with coal tar pitch or asphalt cement on the job it is sometimes a troublesome and expensive business. In order to overcome this there has been introduced a type of filler that comes already mixed. It consists of an asphalt base into which has been mixed some finely divided dust particles. These particles are referred to as mineral filler. Since they are very tiny, it was supposed that they would not settle out, and that the joint filler so made would be a superior product. We had information from the field that some of these materials were not behaving as well as they were supposed to. We obtained samples, and we examined them. Apparently they were satisfactory. However, we devised a new machine that subjected them to a prolonged test, and we found, to our surprise, that every sample plainly indicated that the mineral filler settles to the bottom of the joint, leaving the bitumen alone at the top. Now, that would not have been so bad if it had not been that the manufacturers, knowing that the mineral filler would stiffen the product, had made the bitumen softer than is customary. Hence, the result is that at the bottom of the joint there is a dense layer of mineral filler, and at the top is a layer of soft pure bitumen all ready to flow on the first warm day.

Stabilizing Filler.—Then we thought that maybe this addition of mineral filler may so stiffen the material that it no longer will penetrate to the bottom of the joints. So we made up some small samples of brick pavements and filled the joints by the squeegee method. After the fillers had cooled we turned the pavements upside down. In no case had the filler penetrated the joints sufficiently to show at the bottom.

That set us to thinking again, and we wondered if *any* bituminous filler reaches the bottom of the joints when it is first poured. We made up more samples, and we poured the joints with tar, heavy and light asphalts, and a specialty mixture of asphalt and rubber. We were using plain lugless brick. In no instance was penetration to the bottom of the joints complete in any section. We then tried lug brick, and we found that penetration except with the heaviest asphalt was satisfactory. The asphalt-rubber mixture was somewhat uncertain.

Here, then, is an example of how we can tell by laboratory tests what is happening in the field, and you will observe that practically it is impossible to determine such facts on the job. A few moments ago I told you how we had used glass bricks to observe this same fact. Here were two different tests and we had a double check.

Some of the materials seemed to be unduly brittle at low temperatures. On the job you have to wait until winter to learn how the filter is behaving. In our laboratory we make the weather, and expose the samples to it. We tried out a number of standard state highway fillers. All of them were brittle at 32 deg. F. We had three fillers that are not brittle, but they do not meet any state highway specification. Two of them contain rubber, and the other is a pulverized asphalt that is softened with maltha before it is used. So, apparently,

none of the recognized bituminous fillers are satisfactory at and below freezing temperatures.

There has been much talk about the adhesive qualities of bitumens. Numerous tests have been devised to measure the adhesion of any such material. None of these tests are sure, and most of them are really valueless to the man interested in brick pavements. We know that certain asphalts are fairly non-adhesive. That is, when the asphalt filler is apparently firmly fixed in the joint it may be lifted or pulled out, because it does not adhere to the bricks. All of you have seen cases where a bituminous filler has been applied to bricks that were wet, only to find that the filter would not cling. We are working on this problem now, and we do not know the answer yet. We have experimented with several different machines, but none of them is satisfactory.

Rubber Admixture.—You may have noticed in this discussion that there has been reference made to the admixture of rubber and asphalt. This is a recent development. There are several materials that are said to be mixtures of these two ingredients. As previously noted, we found that one of them contained no rubber at all except in the name. But one of the University of Illinois students who has been helping me in this work has invented a material that gives promise of being exceptionally good. He has a process that is apparently different from any other, and he produces a filler that has some very fine qualities. A patent has been applied for. Recently another similar material has been sent me, and we are investigating its possibilities. It looks to me now as though there is a chance to improve the existing fillers, and rubber is the answer. I think that I am safe in saying that in all probability you will have to modify your present methods of heating and applying. These materials act differently than plain asphalt cement or coal tar pitch.

We have also tried out some materials that are not bitumens. We have mixed Celite with gums and resins. And we have tried sawdust with certain binders, successfully but expensively. We have not neglected the portland cement possibilities, as we have numbers of times tried incorporating it with other materials, trying to get away from the customary troubles of the grout-filled pavement. To date we have some interesting data, but nothing that is ready to be given out. We are, at the moment, undertaking some tests with the new bituminized cement.

Emulsions as Fillers.—During the past three years we carried on a series of investigations on asphaltic emulsions and their adaptability for use in brick pavements. Those who were present at the 1931 paving brick convention may recall that I spoke at some length on the subject. Our research is now complete, and we feel that at the present time the emulsion is not a material that is satisfactory for the filling of the joints of a new brick pavement. We feel that it has a chance to make good in filling the joints of an old pavement. Also, its great adhesive qualities render it suitable for surface treating a brick pavement that has a slippery asphaltic film over it. It will adhere to the film and the brick as well, and it will also hold a cover of grit, pea gravel, sand, or other skid proofing material.

It was in our investigation of emulsions that we became acquainted with the fact that when these are mixed with sand and their behavior is largely dependent on the size and the quality of the sand. We investigated this, and you will find in the Proceedings of the Highway Research Board some data that are striking. The fact that emulsions behave so well or so badly, depending on the company of the sand they keep, made us think that possibly cut-back asphalts and tars may alter their behavior with different sands. The experience of Illinois last summer shows that our suspicions were correct. It was found that rounded river sand when mixed with a cut-back moved around so much that when it was used as a mastic cushion and bricks were laid on it and rolled the action was much the same as if they were on a bed of ball bearings. The sand cushion pushed upward into the joints and almost filled them. We are going to find out which shapes and sizes cause this, and then the contractor may be saved some expense if he will have the sand he expects to use analyzed before he places his order for it.

Surface Film.—Slipperiness of the asphalt film has caused much anxiety, and maybe has lost you some business. The removal of the film by scraping, after an application of whitewash, calcium chloride, B & B, and other such agents has been described in journals and you are acquainted with the possibilities. If the film cannot be removed I suggest the following which the Illinois State Highway Department successfully used: Spray the surface with kerosene using about 1/10 gallon per sq. yd. of surface. Allow the kerosene about two hours to soften the asphalt, and then spread coarse sand or pea gravel, using about 15 lb. per sq. yd. Let traffic iron the grit into the film. Another method is to heat the film with surface heaters, and spread the cover as soon as the asphalt is soft enough to hold it. But this is too expensive.

Acknowledgment.—Abstract from paper presented at last annual meeting of the National Paving Brick Association.

CONQUEST

By Eric Fleming, M. Am. Soc. C. E.

Spurning the spell of distance, cleaving across the land,
Binding mankind's far outposts to all the human scheme,
Cutting the shifting landscape, the highway's level band
Winds through the mountains' passes and over the sluggish stream

That curls beneath the arches of a bridge's rhythmic span,
Down to the mighty gorges in the valley far below,
Where the river's surging torrent is tamed by the will of man,
Balked by the Titan masses of the dam that stems its flow.

The dam that leashes power to turn the distant wheel,
That makes lights glow in cities far—the road that links all near;
The bridge that spans the chasm—all are monuments that seal
The triumph over nature by the Civil Engineer!

From the periodical, "Alpha Aids."

Book Reviews

Theory of Structural Design

STRUCTURAL ENGINEERING, by J. E. Kirkham, Research Professor, Civil Engineering, Oklahoma Agricultural and Mechanical College. Second edition, 759 pages, 5¾ in. by 9 in., hard cloth binding. McGraw-Hill Book Co., Inc., New York City, publishers, Price $5.00.

This edition is patterned exactly after the method used in the first edition. The author states that the work of revision consisted in rewriting a few parts to conform to latest practice. The chapter on highway bridges considers, of course, only steel structures. Welding has been included in the chapter on tall buildings. Practical formulas have been developed based upon slope deflection to obtain stresses due to unsymmetrical loading. The appendix contains a theoretical and practical presentation of the method of slope deflection as applied in the analysis of rigid frames.

▼

Structural Design

STEEL MILL BUILDINGS, by Milo S. Ketchum, C.E., Sc.D., Member American Society of Civil Engineers, Dean of College of Engineering and Director of Engineering Experiment Station, University of Illinois; Consulting Engineer. Fifth edition, 632 pages, 6 in. by 9 in., semi-flexible fabricated hard binding. McGraw-Hill Book Company, Inc., New York City, publisher. Price, $6.00.

This edition contains a chapter on the calculation of the stresses in stiff frames by moment distribution as developed by Prof. Hardy Cross, and detailed descriptions and designs of several typical steel frame buildings, a hangar and an air dock. The specifications for steel frame mill buildings as given in Appendix I have been revised to bring them in line with the latest practice.

The book develops methods of calculating the stresses in framed structures in such a way that the student or engineer may be able to calculate the stresses in any structure even though the framework may be of a new or novel type. Both algebraic and graphic methods are employed for statically determinate and statically indeterminate structures. The details of the design of steel frame buildings are developed for the complete structure.

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County Planning

FINAL REPORT ON A COUNTY HIGHWAY PLAN FOR MORRIS COUNTY, NEW JERSEY, by the National County Roads Planning Commission, Maj. Geo. W. Farny, Chairman. First edition, 44 pages and addenda, 8½ in. by 11 in., mimeographed, paper cover. Published by the Commission. Price not stated.

The object of this report was to study and present a solution to the problems of the road development of Morris County, N. J. It is excellently prepared, clearly expressed, systematically presented, and logically arranged. The following specific road problems in Morris County are discussed and solutions presented:

1. The extent to which there is lack of continuity which prevents a well ordered and unified system of county highways, and the manner of correcting such lack of continuity.
2. The most efficient use and co-ordination of existing county roads by means of interconnections with such roads as, in the opinion of the National County Roads Planning Commission, should properly be included in the county highway system to facilitate traffic movement.
3. The mileage of roads which may be progressively developed as the needs of the county increase and added to the county system in the next 12 years without jeopardizing future maintenance and construction funds.
4. An estimate of the cost of developing the county highway system and maintaining it at a stage which will adequately and economically serve traffic; and
5. The development of a financial structure for obtaining the above aim outlining methods for making maintenance and construction funds available for the purpose.

▼

Origin of Civil Engineering

THE EARLY YEARS OF MODERN CIVIL ENGINEERING, by Richard S. Kirby, Associate Professor in Yale University and Philip G. Laurson, Associate Professor in Yale University. First edition, 324 pp., 6 in. by 9¼ in., hard cover, cloth binding. Yale University Press, New Haven, Conn., publisher. Price, $4.00.

In the belief that civil engineers, and, perhaps engineers generally, know little of the history of their profession, the authors have gathered together material relating to the pioneers and pioneering work in Europe and America during the eighteenth and part of the nineteenth century. During this period there were few, if any, textbooks, handbooks, periodicals, engineering schools or associations of engineers, and consequently the material concerning it has been widely scattered, with a considerable portion of it in foreign languages. "The civil-engineering profession," says Professors Kirby and Laurson, "may be said to have originated in France early in the eighteenth century. However, the first man definitely to call himself a 'civil' engineer was a keen Englishman, John Smeaton, in 1761. . . . And it is from Smeaton's day and, indeed, under his influence, that the first formal definition of the new profession was advanced. . . . It is with the period of early development of this profession, whose descent may be traced in part both from architecture and from military engineering, that the book deals."

It is plentifully illustrated.

▼

Human Comfort

AIR CONDITIONING FOR COMFORT, by Samuel R. Lewis, Past President American Society of Heating and Ventilating Engineers. First edition, 244 pp., 5⅛ in. by 8¼ in., illustrated, hard cover, cloth binding. Engineering Publications, Inc., 1900 Prairie Ave., Chicago, publishers. Price, $2.00.

This volume has been issued in response to the almost universal interest in the subject of air conditioning as it may be applied to the home and to smaller stores, offices, etc.

The book treats of theory and practice. It takes the reader logically through the fundamental data required in the designing of a system of air conditioning; shows the application of the formulas developed to the necessary calculations; and finally proceeds to the actual calculations required for two residences and a restaurant installation.

It is indicative of the practical viewpoint adopted by the author that he has insisted throughout the book on this thought: "Heating systems are considered in this book along with cooling systems," he says in his preface, "because of the very close relation between the two, and because it appears inevitable that the best cooling systems of the future will be those, the designing of which was borne in mind when the heating system, with which it co-ordinates, was designed.

Municipal Information

CITY MANAGER YEARBOOK, edited by Clarence E. Ridley and Orin F. Nolting. First edition of 1933 book, 356 pp., 6 in. by 9 in., hard cover, cloth binding. The International City Managers' Association, 923 East 60th St., Chicago, publishers. Price not stated.

Municipal Administration in 1932. The Nineteenth Annual Conference Proceedings, the Association business, and a City Manager Directory are the main divisions of the book. Planning, budgeting, revenues, assessments, public works, zoning, recreation, housing, public utilities, management, education, health and such topics are matters of the consideration of this book. Each subject is discussed by an authority on that subject and compiled under the heading of Municipal Administration in 1932.

A large section of the book is devoted to special articles written on Management Technique by various specialists. The book is chock full of information, that can readily be applied by the engineer or councilman and adapted to the development of his particular community.

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Railroads and Government

PUBLIC AND PRIVATE OPERATION OF RAILWAYS IN BRAZIL, by Julian S. Duncan, Ph.D., Department of Economics, St. John's College. First edition, 243 pp., 6 in. by 9 in., hard cover, cloth binding. Columbia University Press, 2960 Broadway, New York City, publishers. Price, $3.75.

Government subsidy to privately built and operated railways enabled Brazil in 1855-90 to utilize lands and resources far in advance of the time when private capital alone would have made such development possible. But the depreciation of the currency which began with the Republic in 1889, the low traffic density of the majority of the lines, and other operating difficulties caused the government to recapture some of the lines before the guarantee of interest expired. Still others failed after their guarantee of interest period ended. Most of the less profitable roads were taken over by the government. At present there are three types of operators: the federal government, state governments, and private companies. This study is an attempt to discover which type gives the best results from the standpoint of national economic well-being.

This discussion of the process by which the government came to own and operate more than half of the total mileage in Brazil may throw light on what might happen in the United States if loans of the Reconstruction Finance Corporation to railroads continue.

The author lived in Brazil for three years and recently spent another five months in reviewing the published material, talking with government officials and company executives, and traveling over the main divisions of the roads studied. All the important railway shops were visited and trips in the cabs of locomotives or on the rear platforms of trains enabled the author to inspect the right of way.

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Mortar and Concrete

UBER MÖRTEL UND BOTEN, by Magistratsoberbourat Dr. Paul Herman, Technishchen Unterschungsamter der Stadt Berlin. First edition, 132 pp., 6¼ in. by 9 in., hard cover, cloth binding. Allgemeiner Industrie-Verlag, G. M. B. A., Berlin, S. W. 11, publisher. No price stated.

This book is a technical discussion on experimental work with mortar and concrete of the research department of Berlin. It gathers together discussions on various properties and characteristics of cements of all kinds.

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Testing Bitumens and Aggregates

WIE PRÜFT MAN STRASSENBAUSTOFFE, by Dr. Ing. W. Bierhalter, Professor Dr. Karl Krüger, Dr. Ernst Ohse, Dr. Albrecht von Skopnik, Dr. Ing. Kurt Stöcke, all of Germany. First edition, 157 pp., 7 in. by 10½ in., paper cover. Allgemeiner Industrie-Verlag G. M. B. H., Berlin, S. W. 11, Germany, publishers. Price not stated.

Asphalt, tar, and stone testing are the subjects of the matter in this book. The various tests as employed in Germany are thoroughly discussed and illustrations of testing equipment are included. Tests of aggregate are first taken up and then followed by tests on bituminous materials. The general arrangement of the book is logical, simple and complete. Distinction between natural and petroleum asphalt is made, as well as between tar and pitch. Asphalt and tar emulsions as well as rock asphalts are discussed from the qualitative and quantitative testing viewpoint. The purpose of the book is to indicate what bituminous materials are suitable for road and street work.

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Highway Curves

ELEMENTS OF CURVE DESIGN, by F. G. Royal-Dawson, M. Inst. C. E., M. Inst. T. (England), Late Professor of Roads and Railways. Royal School of Engineering, Cairo. First edition, 230 pages, 5 in. by 7 in., hard binding, fabrikoid cover. E. & F. N. Spon, Ltd., 57 Haymarket, S. W. 1, London, England, publisher. Price, 8/6 net (approx. $1.45).

In the railway field, curve mechanics and transition problems have been quite definitely worked out. They are different, however, from curve problems in highway work because lateral thrust, in the case of railroad curves, is taken up by flanges of car wheels while in highway curves the outward thrust must be resisted by superelevation and tire friction. The latter presents a variable problem because of the differences in resistance between tires and various surfaces. Regarding American practice the author states as follows:

"American highway literature gives some attention to transitions, but only to the extent of suggesting empirical formulae for the length, again based on superelevation. In this they follow the lead of the railways, for it is characteristic of American formulae for railway transitions that the latter are based on the superelevation factor only, to which the actual centrifugal factor is only indirectly related. So that, although such formulae may serve the purposes of the railways which use them, they are fundamentally misleading as a guide to road transition where there is little or no relation between actual speeds and actual superelevation (if any).

"The crux of the whole problem is the determination of the theoretically correct length of transition for a given radius and a given standard of speed."

Actual employment of the principle of transitioning by a driver of a motor vehicle will be seen if one studies the path of a vehicle being driven around a curve which is too sharp or which has not been superelevated or transitioned. There is no doubt that curves should be superelevated, and also that they should be transitioned. The question of basing the transition on curve radius and speed rather than on superelevation is a rational approach to curve problem solution.

EDITORIALS

The Egotism of Scientists

Professional jealousy flowers as luxuriantly in the prosaic fields of science as in the poetical gardens of art. Tycho Brahe, the leading astronomer of his day, condemned the heliocentric theory of Copernicus. Newton saw nothing but defects in Huyghen's wave theory of light. Braun, the great German geologist, ridiculed the ice-age theory of Agassiz. Agassiz saw no truth in the Darwinian theory of evolution. Only Planck approved Einstein's theory of relativity when it was first published. Thousands of physicists remained either skeptical of, or openly hostile to, that theory for many years.

"Scientific caution" has usually been alleged as the cause of such skepticism and hostility. But the blunt truth is that most scientists dislike hearing that their old theories are even slightly defective, and strenuously resent being told that they are wrong. The bitterness of their attacks on a new theory that aims to displace an old one is engendered by something else than "caution." That something else is egotism that resents the charge of ignorance.

Every scientist concedes that Newton was right when he said that the knowledge that he had gained during his long and industrious life was as nothing compared with what remained to be wrested from a secretive Nature. Yet nearly every scientist gives only lip-service to that doctrine, even as Newton did; for let a new theory present itself for approval and you will find nearly all scientists not merely ready but eager to give it a push into oblivion. Does that indicate the humility that they profess? Does it point toward a belief that they really know but very little?

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Earthquake and Automobile Fatalities Compared

MILNE'S "Catalog of Destructive Earthquakes" lists about 5,000 great quakes that caused the death of about 2,500,000 people during the first 1900 years of the Christian era. One quake alone killed about one-third of this entire number in China, in January, 1556. Since the early records of deaths are very incomplete, we shall consider only the deaths recorded from 1600 to 1933 A. D. These total about 1,800,000, of which 467,000 occurred during the first 33 years of the present century.

Taking the 1,800,000 deaths subsequent to 1600 A. D., the rate has been 5,400 per annum. This embraces the entire earth, yet it is one-sixth as many deaths as are caused annually by automobiles in America alone.

In Los Angeles County, where the recent quake killed about 135 people, that many are killed every 60 days by automobiles. There is no previous record of a single death from earthquakes in Los Angeles County. At Santa Barbara, 11 were killed by the quake of 1925. At San Francisco 452 were killed by the quake and fire of 1906. These embrace practically all the earthquake deaths recorded in California since the coming of the white man. Even if we regard these 598 deaths as being assignable to only the last 50 years, the rate is 12 deaths per annum, or about as many as are killed in California annually from slipping on banana peels.

The spectacular nature of an earthquake and the feeling of helpfulness that it arouses account for the panic that seizes most people who have not previously experienced such a catastrophe. But the very same people go about their business serenely and take risks thousands of times greater without giving a second thought to them. This springs largely from the fact that few men are trained to interpret statistics and habituated to act upon information thus derived. In addition there is the psychological reaction to every spectacular evidence of the power that Nature discloses when she goes "loco." Whether it be a tornado, a tidal wave, a volcanic eruption or a quake, most men instinctively become panic stricken. The writer recalls a tornado that cut a swath through a Puget Sound forest, uprooting trees four feet in diameter and filling the air with flying branches. Two dozen of us, who were building a highway bridge, rushed to an open spot and lay flat on our bellies, hardly daring to look up. After the storm had passed by us, there we still lay for some minutes, most of us clutching weeds with both hands, as if their puny roots would anchor our bodies to the earth. No statistics would have persuaded any of us during those few minutes that we were really not about to die.

But when the tornado passes on the earth ceases trembling, then we may, and we should, guide our actions by statistics. Thus guided Californians may well be unafraid of quakes and shun banana peels.

W. P. Gillette

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Racketeering

APPARENTLY contracting is a profitable field for racketeering. Contractors in a certain county in Illinois, the writer was told the other day, dare not call their souls their own. This was two weeks previous to the outrage quoted below from the March 17th edition of the Chicago Tribune.

There are ways, perhaps not strictly legal, of coping with this situation. Contractors might well adopt extra-judicial measures for their protection. No doubt county and state highway department engineers would lend a sympathetic ear to plans proposing the eradication of racketeering. In the end, the people must pay the bill extracted by these un-American bloodsuckers.

BOMBERS WRECK MACHINES; SEE LABOR TROUBLE

Bombers destroyed three pieces of road machinery, valued at $19,000 early yesterday, in McHenry county, five miles north of Woodstock, the county seat. One of the machines, a crane, was standing in the yard of Mark Hansen, a farmer, living near Hebron, and the blast smashed all the windows in Hansen's house and barn, and drove a piece of steel through the wall of his home. The fragment was stopped by the door of a room in which two of his children were sleeping.

The bombings, which were virtually simultaneous, were heard over a radius of 15 miles. Sheriff Lester Edinger of McHenry county said he believed the attacks were due to labor troubles involving the companies owning the machines. These companies are the Harrison Engineering and Construction Company of Kansas City and the Gates Construction Company of Ottumwa, Iowa.

Both employ non-union labor, and last summer $10,000 worth of their machinery was destroyed by bombers. George (Red) Barker, Chicago union racketeer, who has since been murdered, was blamed for the earlier bombings, although no arrests were made. The companies did not finish their road contract—the construction of eleven miles of state route 47—last fall, and were to have reopened their activities soon.

V. J. Bowers

County and Township Roads

A Section Devoted to the Interests of Those Responsible for Secondary Road Improvement

Farm to Market Road Program *Suggested for Massachusetts*

By L. O. MARDEN

County Engineer, Worcester County, Massachusetts

NOTWITHSTANDING the fine state highways, which include super-highways and secondary road systems that crisscross the state in so many directions, there are at present in Massachusetts 11,000 miles of dirt highways, many of which are in about the same condition they were 100 years ago. These 11,000 miles of dirt highways are 44.6 per cent of the 24,600 miles of the roads in the state. Besides these dirt roads, there are 7,900 miles of highways that have some sort of a hard surface, and 5,700 miles of highways in city streets and park systems that have a high type surface.

Mr. J. A. Johnston, District Engineer of the Department of Public Works, at Worcester estimates that 2,400 of these 11,000 miles of dirt roads are composed of mud-holes, or places impassable during the wet seasons of the year; the remainder of the mileage being in extremely poor condition in that kind of weather. They may be divided into two classes: First, the town center to town center roads, which are being gradually improved by the state, county, and town, under the Chapter 90 Act, and of which there are 4,000 miles more to build. The limited amount of money being spent on this type of road, however, has left many small towns still connected with the outside world only by dirt roads. Secondly, the back roads leading off secondary highways, upon which a large part of the rural population lives, and which are the original dirt, are for many miles absolutely impassable to motor vehicles, as has been stated, during certain seasons of the year.

Statistics show there are 25,598 farms in Massachusetts, having a total value of land and buildings of $261,222,390. These farms have a total acreage of all kinds of land of 2,005,546 acres; 474,167 acres produce crops, having an annual wholesale value of $31,000,000. These farms have a population of 150,000 people. The 1930 census of agriculture recently completed by the United States Census Bureau shows that less than one-tenth of the farms in the United States are on better than gravel roads. I believe it to be a fair figure to assume that an average of 15 per cent of the farmers in Massachusetts (about 21,500 farms), are on roads other than dirt. This figure would of course be higher in the eastern portion of the state. Worcester County, by the way, has 2,800 miles of dirt roads, or 26 per cent of the total state dirt road mileage. For example, 1930 statistics show that the 57 towns in Worcester County have a population of 214,000 people, or about two-thirds the population of New Hampshire, and that 62 per cent of the highways that serve this population are dirt roads. The total value of farm land and buildings in Worcester County towns is $41,632,031, and the average wholesale value of crops produced is around $11,000,000. Surely a business the size of the farm industry in Massachusetts deserves an adequate road system from farm to market.

In this connection allow me to say that there must by many farmers among the members of this association, and that there are probably very few members among you that have not at one time or another been stuck in the mud with a load of milk or other farm produce. When a man undertakes to run a farm in these times he is undertaking a man's job, and a good road to his farm is his just right and as much a part of his farm equipment as his barn, his electric lights, or his electric pump.

Gentlemen, the farmer has in many cases been paying out his good money for taxes year after year and has received no aid on his particular back road; he sees state highways and secondary roads built that speed him to market after he gets off his dirt road, but he has yet (in the case of the average farmer living on a side road) to see a good road built to his farm.

How are we going about eliminating these mud holes, and constructing a farm to market road system?—In Worcester County, for example, under the Small Town Act, or Chap. 81, about $177.00 per mile is available for the maintenance of the dirt roads. This amount is, of course, entirely inadequate as results during the past 25 years show. Under Chap. 90, about $500,000 per year has been available in the county for town center to town center road construction. It is probable that these figures would vary in each county, but that the net results are the same. If the same percentages of money are expended each year, it would probably take 50 years to construct a farm to market road system.

It is also very probable that if no concerted effort is made at the State House, the legislature will take another $8,000,000 or $10,000,000 from the Gas and Motor Vehicle Tax Fund, so that practically no money would be available under Chap. 90 for 1933 road construction.

How should we proceed to provide good roads for the rural communities?—1. By the mud hole program, which would gradually fill all mud holes to definite lines and grades, so that work done on them would form a

part of a future hard surfaced highway. The mud holes should, of course, be first eliminated on those highways on which school buses and rural mail carriers travel. The state district engineer at Worcester estimates that it will cost the state $10,000,000 to fill the mud holes on the dirt roads, before through lines of communication can be estimated; 20 per cent of the dirt roads are impassable mud holes.

2. By the progressive or stage type of highway, some towns in the state will, of course, have their mud holes practically eliminated. Those towns could proceed with this type of highway. That is, the gradual improvement of the highway as is demanded by the increase of traffic. Part of our existing dirt roads that have had some treatment of gravel under Chap. 81, could be regraded, properly graveled, and given a bituminous treatment. These roads should of course have their drainage properly studied. The use of local, or short-haul materials, would help keep down the cost of this type of highway. The chief of the United States Bureau of Public Roads states: "As a matter of fact, to a large extent, all highway construction must be stage construction, and there can be no just criticism of whatever is undertaken if it can be undertaken intelligently with a well defined conception of the future development, and if the execution of the idea is efficient." All construction on dirt roads should be supervised by the Massachusetts Department of Public Works and can, I believe, be undertaken under Chap. 90 and paid as provided by this law by the state, county, and town. Whether the existing laws should be changed is a matter of legal advice.

Experimental farm type roads constructed in Worcester County.—Two experimental pieces of highways that might be called the progressive or stage type of highways, and which will form a part of a farm to market road system, are now being constructed by the town of Sterling, under the supervision of the Department of Public Works. The preliminary surveys and plans which involved some relocation, staking, county layout, and setting of county bounds were made by the Worcester County Engineering Department. This highway consists of a standard stone fill, 10 ft. in width and 8 in. in depth, which rests on a proper subgrade, 4-ft. gravel shoulders, 6 in. in depth, the whole being covered with a layer of gravel for its entire width of 18 ft. This surface is penetrated with an application of ½ gallon of bituminous material, followed by a seal coat of 0.4 gallon of bituminous material per square yard. Three miles of this type of highway have been constructed during 1931 and 1932, at a cost of about $10,000 per mile. Maintenance charges on a road of this type would probably amount to about $300.00 per year, after three years, per mile of road. There would undoubtedly be small maintenance charges per mile during the first two years, of not over $50.00 per mile. In other words, this type of road can be built for $10,000 per mile and less, depending upon the condition of the existing road and upon the type of country through which road passes.

The highway superintendents in different towns have reported at meetings held by the Extension Service in Worcester County, that they have constructed a blanket surface of gravel and bituminous material on back roads, improving drainage at the same time, but using mostly the old grades and curves, for from $3,000 to $5,000 per mile.

What savings are made in the cost of operating motor vehicles over a road of this type?—From investigations made by Professor Agg of the Iowa State College, and adjusted to records of Massachusetts motor vehicles as revised to 1932 prices of motor supplies, by Mr. J. A. Johnston, District Engineer at Worcester, we find that the cost of operation on an intermediate type of road similar to our hard-surfaced farm road, for all types of vehicles including trucks, is 10¾c per mile, while the cost of operating on a dirt road with mud holes is at least 13¼c per mile. This is a saving of about 3c per mile per vehicle. Let us assume a traffic of 60 vehicles per day on our farm road. This shows a saving of $1.80 per day operating charges, or $657.00 saving for one year. This amount of money is interest at 6 per cent for a principal sum of $10,950; in other words, the saving is sufficient to pay interest on the cost of one mile of farm road, at about $10,000 per mile. Statistics also show that salesmen have found their savings to be 2½ to 3c per vehicle mile operation on hard surfaced highways over dirt roads.

Other Savings to People.—Many other savings to the people, such as saving of time, ease of marketing farm products, and closer contacts to shopping centers, are also of great value. Properties in entire communities will increase in value; abandoned farms will be built up; and houses constructed on cellar holes of many old homesteads. Good roads also build up the morale of a community. Bad roads make it impossible for the postman to deliver mail, for children to be transported to school, and for the country doctor to reach his patients.

Mr. Charles Heslam, a successful farmer living on Pearl Hill Rd., Fitchburg, a stretch of dirt road which, I understand, has been recently improved, estimated that more than 200 farmers bring their produce to Fitchburg over this road. Many of their farm products on account of being damaged by the old bumpy road, lost their "Class A" value and became a "Class B" product. The annual loss to these 200 farmers, on account of this reclassification of their farm products, would probably be sufficient to reconstruct this mile of highway every year.

How can this mud-hole and farm to market road program be financed?—In the first place, a strenuous fight must be made by all interested in roads to keep the Gas and Motor Vehicle Tax Fund for the purpose for which it was intended; namely, highway construction. Several public officials have recently come out for the diversion of this fund for use to relieve the unemployed by giving them a dole. The mayors of the Massachusetts cities are said to be advocating that $15,000,000 of the funds derived from gas tax, and other motor vehicle funds shall be diverted from work done under the supervision of the Department of Public Works, and placed at the disposal of the municipalities for expenditures as they may desire. The title of the Massachusetts Law providing for the taxation of sales of gasoline and certain other motor vehicle fuel is: *"An Act Changing the Method of Raising Funds Toward the Cost of Construction and Maintenance of Highways and Bridges by Providing that the Excise Tax on the Privilege of Registering Motor Vehicles as Fit for Operation on the Highways Insofar as It Relates to Such Operation by Means of Gasoline or Other Petroleum Products Be Measured in Part on the Amount Thereof so Consumed Instead of Wholly Upon the Horsepower of Weight and Carrying Capacity."* (Chap. 316, Acts of 1928.) The title clearly indicates the original purpose of the tax. It was enacted as a "Method of Raising Funds"; in other words, a tax upon motorists for highway purposes is very plainly an illegal act.

This program must be financed by the Gas and Motor

Vehicle tax, and constructed under Chap. 90, with some financial help from the cities and towns. If this money is taken from the Gas Tax Fund, the gas tax should be done away with.

What benefits will be derived by this program?—This fund provides money for constructive work on highways by the unemployed; at least 80-85 per cent of the cost of highway construction is labor. It will permit towns to use their moneys for other purposes. More roads can now be built as costs have fallen to 25-30 per cent below those of 18 months ago, and only about one-half that of 5 years ago, according to ROADS AND STREETS magazine. We are building value in our communities for the future. There are more automobiles today than good roads upon which to operate them. In fact, there are in Massachusetts 31 vehicles to every mile of road. More good roads will mean money saved on account of lower operating cost.

Importance of Maintaining Highway Funds.—Not only will highway funds be necessary on construction of types of highways other than farm roads, but it is extremely essential that maintenances be continued on all existing highways. All money in the highway fund must be kept for highways, as statistics show that Motor Vehicle Registry fees have declined during the first ten months of this year from $6,294,544.33, to $6,009,538.43, or a decrease of $285,005.90. The Governor says: "Highway taxes must be devoted to highway purposes." He also states, "That gasoline taxes do not come under the head of current revenue." The 1 cent Federal Tax, if eliminated by the Federal government and replaced by a sales tax, would help towns in this section of the country with their appropriations. Altugh the money received from this tax by the Federal government is spent on highways. The West and South receives more money in proportion to what they pay in than the densely populated East. To sum up, the mud hole and farm to market road program, will materially assist the farmers and the unemployed in cities and towns, as follows:

1. Will keep the unemployed at work on constructive highway projects, as 80-85 per cent of the cost of this type of highway construction is labor.
2. Will bring more people to the farms, and help decentralize population, which is necessary during this depression.
3. Will increase the value of farm lands and buildings.
4. Will reduce losses to farmers in marketing their farm products.
5. Highways should be constructed under the direction of the Massachusetts Department of Public Works, so that money should be economically expended, under the Chap. 90 Act, be it city or town.
6. Will enable towns to use their moneys raised for other purposes.
7. Will assist in lowering the county tax.
8. Will assist in building up abandoned farms.
9. Will place the farmer in better contact with markets.
10. Will promote better neighborhood spirit.
11. Will increase amount of taxable property in rural districts.
12. Will assist in transportation of mail and school children.
13. Will place the state once more in the rural column.
14. More people on farms would mean more farm products home-grown, and used by the state as a whole.

15. Program would create sales in many commodities and stimulate business.

16. Farm to market and mud hole program should have certain planned number of highways to be improved every year, so that in a definite period, say, 10 years, the system would be completed.

17. Highway fund must be left intact for highway purposes.

Acknowledgment.—This article was prepared as a speech before the Bristol County Selectmen's Association of Massachusetts. Information and assistance rendered and used in this article were obtained from the following: J. A. Johnston, District Engineer; Massachusetts Department of Public Works; American Road Builders' Association; ROADS AND STREETS; Worcester County Extension Service; Massachusetts Farm Bureau Federation.

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Road Jobs Reduce Counties' Expenses for Public Relief

County officials from many parts of the state of Minnesota are writing to the Minnesota Industrial Commission urging a continuation of state highway work as a means of taking unemployed from the public relief lists and relieving the burdens of the general taxpayer, according to J. D. Williams, Chairman of the Commission.

The commission last fall aided 71 Minnesota counties in placing 10,000 of their unemployed on 38 State-Federal road jobs. State highway work is not paid for by the general taxpayer.

Following are extracts from a few of the letters received by the Industrial Commission in the past few days:

E. H. Smith, County Commissioner, Waseca County: At least 30 per cent of 500 men employed on the McCree job were from our county. They were placed by giving unemployed ex-service men with families preference, and then married men next in order. It certainly was a Godsend to the unemployed men of this county. I was besieged every day by good, honest, willing men begging for a chance to earn a living for their wives and children. Since the work stopped last fall these same people have had to ask for aid for fuel and food. Many of them suffered rather than become subjects of charity. My earnest wish is that more of such work be arranged for this year. There is very little other work in sight.

Frank J. Ibach, County Auditor, Fillmore County: I would like very much to see the highway projects continued along the same lines as last year. It proved a great blessing for the laborers of this county, and already we have had several requests and have at the present time about fifty applications for work on these projects. In 1932 we sent 106 men to jobs at Grand Meadow and Austin.

C. U. Landrum, County Attorney, Becker County: This work undoubtedly kept at least fifty families in this county from becoming county charges. The situation here was very bad indeed at the time this employment was furnished, and I say without hesitation that it furnished the means of living to a number of families. Unskilled laborers and teamsters, in many instances, would have had to receive aid from the poor funds of this county if the work had not been given them.

H. R. Ost, County Commissioner, Chippewa County: The County Emergency Relief Committee has gone on record as being in favor of appropriations being made for state highway work as in the past. Last year a large number of men from this county were given employment through highway work.

BEFORE Sundown

TO round out a complete service of information for the convenience of the traveling public in Jackson County, Missouri, a special map signboard with a complete layout of the state road system (state and county) has been erected at the intersection of the Outer Belt, north of Oak Grove, with U. S. No. 40. The state highways are brought out with white luminous buttons, the county highways are in red, and the observer's point is shown with a green star. The accompanying pictures show this map, both in daylight and from the driver's seat of an automobile at night. It has attracted considerable attention and created some very favorable comment, which leads us to believe that it will be well worth while.

The signboard is 12 ft. high, 10 ft. wide, made of steel channels for the frame with 20 gauge sheet metal for the back and 16 gauge metal for the front. Holes are punched in the front for the insertion of the reflector buttons. The front face is removable for maintenance purposes. The front and back sheets are rigidly held in place by angle iron separators. All bolts and fittings are cadmium plated.

The experiment will be watched with considerable interest to see whether or not the county will erect similar signs at all entrances of important highways.

Jackson County is completing a 310 mile system of highways from funds made available by the $6,500,000 bond issue of 1928 and the $3,500,000 issue of 1931. These highways fit in with, and will become a part of, the proposed regional plan highway system for Kansas City and surrounding territory. This county system of roads was designed with the state highway system as a basis.

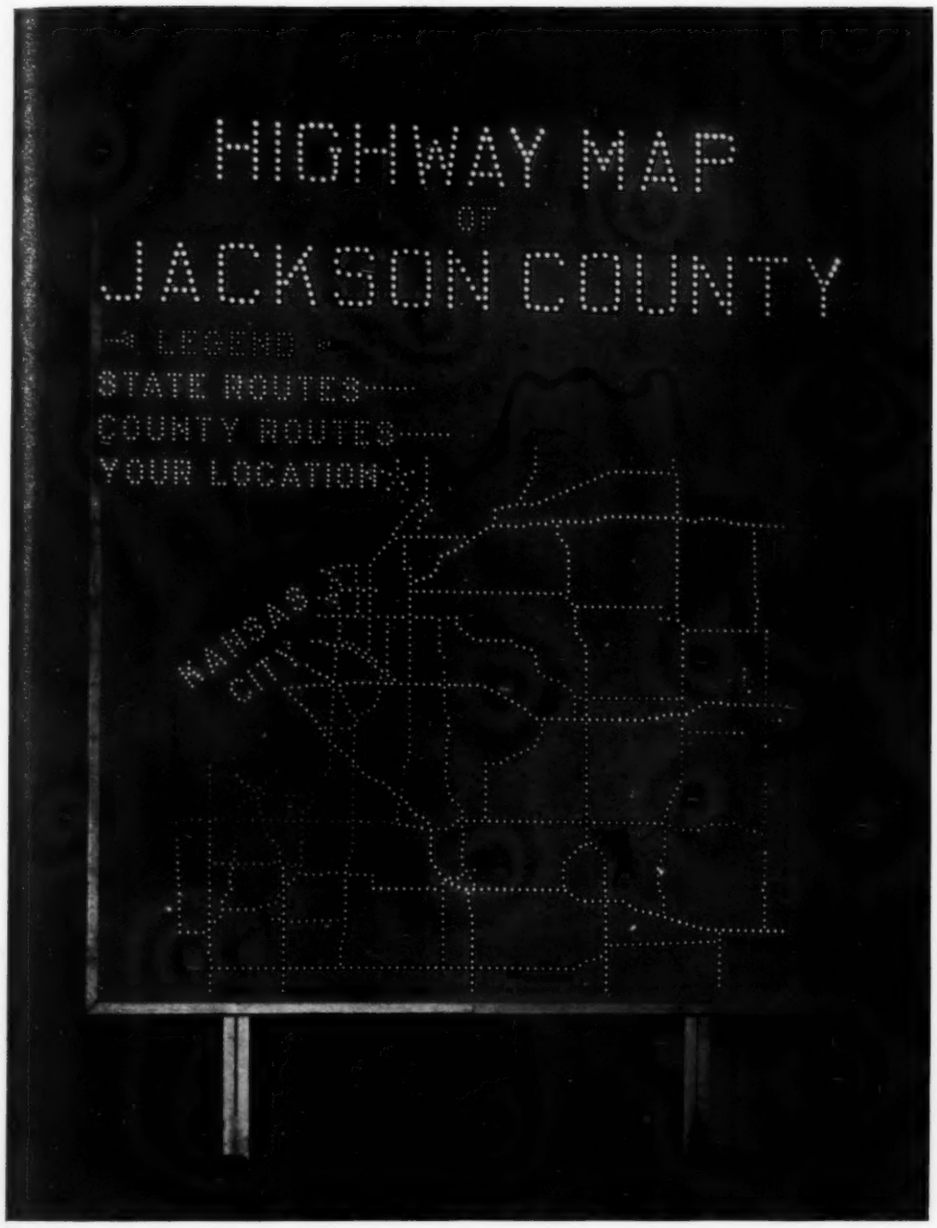
In cooperation with the state, junctions and intersections are made safe by using widened intersections. The Cook County intersection has been modified to the star shaped intersection, which is more satisfactory. Cooperating with the railroads, many bad railroad crossings have been eliminated by grade separations.

By Wm. M. Spann

Field Engineer, Jackson County Highway Department

The plan being carried out by Jackson County for numbering these highways is such that it can be used in the numbering of highways for the entire regional area. This system is based on a set of co-ordinate lines at right angles, north and south, and east and west, through a point where U. S. Highway No. 40 intersects U. S. Highway No. 71, these being the main axes of communication, at Linwood Blvd. and Paseo Blvd. in Kansas City, Missouri. This point is approximately in the center of the regional area. All roads are numbered

and AFTER Dark



consecutively by mileage east, west, north or south from these co-ordinate lines.

Designation of routes will be accomplished by means of a number together with a suffixed letter—the number indicating the approximate distance in miles and the letter the direction—giving the definite location of any particular road with reference to these co-ordinate lines.

For example, an east and west highway which is 8 miles south of the east and west co-ordinate line will be numbered "8-S." In addition, the route marker will carry the historical name for each individual road.

The County System is marked with standard information, direction and warning signs, based on state highway standards as adopted by the Bureau of Public Roads. The route marker is the outline of the county with the name of the road and its route number stamped thereon. Black letters are used on white background. Wooden fingerboards are used for direction and information. All of the cautions or warning signs are made of 16 gauge sheet metal, galvanized to prevent rust. The lettering and arrows on important signs on those of special significance are emphasized by using reflector buttons, white for caution and red for danger.

The leader in this outstanding development of Jackson County roads has been Harry S. Truman, Presiding Judge of the County Court. The successful execution of the plan was under the direction of a bi-partisan board consisting of E. M. Stayton and N. T. Veatch, Jr., Consulting Engineers of Kansas City, Missouri.

With the completion of its first step in county planning, Jackson County now has paved highways through all important sections. It has an inner belt highway circling Kansas City close in. It has an outer belt highway circling the remote parts of the county. It has connecting links at strategic points. It has many miles of farm-to-market roads important to a large farm population. And it has eliminated hundreds of miles of costly highway that literally "ate up" tax money in maintenance.

It is only part of an all-embracing plan for giving Jackson County its deserved opportunity to live up to its possibilities. Coming days will see advantageous development of the Big Blue River, the Little Blue and Sin-a-Bar Creek. The county plan was based on practical needs; it was carried out along practical lines; its effect will be for the practical benefit of every citizen.

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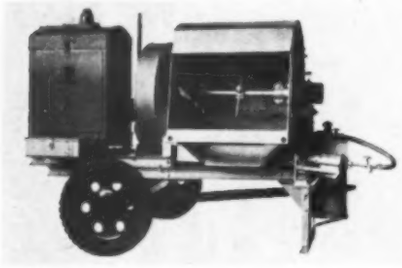
HIGHWAYS OF FRANCE.—The area of France is 212,726 square miles and the population about 41,130,000. France has approximately 405,132 miles of highways, divided as follows: national highways, 49,814 miles; departmental roads, 7,585 miles; and vicinal roads, 347,734

New Equipment and Materials

New Bituminous Mixer

The Kwik-Mix Division of the National Equipment Corporation, Milwaukee, Wis., has published a bulletin describing a new bituminous mixer recently developed by them. It is built in two sizes—6 to 8 cu. ft. and 10 to 12 cu. ft. It has specially designed, adjustable, manganese "saw-tooth" blades, with a criss-cross mixing action. A detachable heater is conveniently located at the end of the machine away from the engine, for safety and efficiency.



New Kwik-Mix Bituminous Mixer

The indirect application of heat, by means of a shell around the drum, is stated to cause even heat and therefore, the material is not burned, neither does it become "balled".

Special features are claimed to bring about easy operation and thorough, efficient mixing of evenly coated material. These machines are used for placing of cold or hot patch material on location, for bituminous roads. They are also used for centralized plant operation, or for many other surfacing projects.

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"Caterpillar" Announces New Power Controlled Elevating Grader

Caterpillar Tractor Co. of Peoria, Ill., has announced a power controlled elevating grader of new design and great capacity.

This machine incorporates such features as an arched "A" frame giving ample clearance for the carrier and permitting a higher lift for loading large wagons. Three point suspension of the frame protects it from twisting strains, and a swivel king bolt allows full oscillation of the front wheels and extremely short turns. Drum type wheels cannot clog with dirt and both front and rear axles are extensible to balance the weight of the carrier.

Full power control is provided through a gear box similar to those used so successfully on the "Caterpillar" auto patrols. Four power levers control adjustments of carrier and plow and all operating controls, including clutch, throttle and gong are grouped within easy reach of the operator's seat directly over the plow.

A 46 horsepower "Caterpillar" engine, mounted on a sub-frame at the left side of the rear axle, furnishes power to operate carrier, power controls and automatic pan cleaner. This mounting of the engine balances the weight of the carrier, gives the operator an unobstructed view and removes him from the heat and exhaust of the engine.

Exposed chains and gears are eliminated. The 48-in. belt is driven by enclosed gears and a universal shaft along the rear of the carrier. Power control, adjusting hoists, and automatic pan cleaner also have enclosed gear drive.

The standard 19-ft. carrier may be increased to 22 or 25 ft. by adding 3-ft. extensions. The belt is provided with an automatic reverse check so that its load of dirt cannot roll back in front of the plow when the clutch is released.

The steel carrier is built with heavy tubular spacers and strong diagonal braces. Steel belt rollers, mounted on roller bearings, are spaced 12 in. apart. A "V" cleaner floats flat on the returning belt and a gear-driven pan cleaner provides positive cleaning in front of the lower drum.

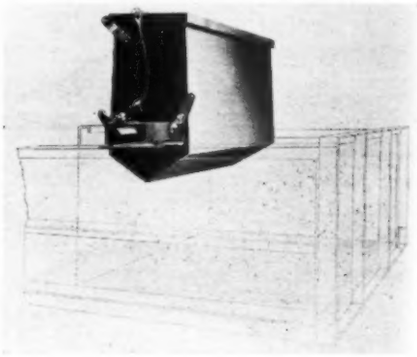
The "free floating" plow beam is a built-up box section weighing 675 lbs. It is suspended on chains, and this mounting protects the plow from hidden obstructions, insures a uniform furrow and permits easy, accurate adjustment of the plow.

Ball and roller bearings are used throughout the carrier drive and adjusting gears. The wheels are mounted on tapered roller bearings equipped with dust seals.

New "Caterpillar" Elevating Grader on J. R. McLean Job in St. Croix County, Wis.

A New Type of Tipover Cementank

Blaw-Knox Co. of Pittsburgh, Pa., has developed a new type of tipover cementank for hauling bulk cement in compartment trucks on road construction. The cementank is a steel container with hinged steel cover and is supported on the sides of the truck. It is filled with cement at the proportioning plant and then dumped into the skip of the paving mixer at the same time that the load of aggregate is released.



Blaw-Knox Cementank

The Blaw-Knox tipover cementank is oversize in capacity to take care of bulking or fluffing of cement, which usually swells the volume considerably. This cementank can not leak and is weather proof at all times. It is held upright by means of a latch, absolutely preventing accidental dumping. To discharge this tank it is only necessary to throw a little lever at the side, releasing the latch—and when the truck body is elevated the cementank turns over automatically and, as stated above, discharges its batch of cement with the aggregate with a minimum of dusting.

A feature of this new cement container is the simplicity and ease of installation, only four bolts being required to attach it to the side of the truck. Another important advantage is that this unit occupies a minimum of space in the truck body as it sets up high and does not protrude appreciably down into the compartment of the truck. This makes it unnecessary to build up the sides of the truck so that it will hold the normal batch. The Blaw-Knox cementank also occupies a minimum of space in the length of the truck, so that the loading of the truck compartment with sand and gravel is not obstructed. The Blaw-Knox cementank is furnished in two sizes—(1) for batches containing six bags of cement or (2) seven and one-half sacks of cement.

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New Blanket for Curing Concrete

A new blanket for curing concrete has been placed on the market by the Western Felt Works, 4029 Ogden Ave., Chicago, Ill. It is stated to be constructed in such

a way that it will hold moisture in the concrete for a longer period than ordinary burlap and thus insure a better and more even job of curing.

The blanket is made of a filler of jute fibres (the same material from which burlap is made), punched or needled between two layers of burlap. This, in turn, is coated with rubber latex making the blanket slightly waterproof and retarding the evaporation of moisture from the concrete. This method of manufacturing adds to the life of the blanket and it is claimed it can be handled and used repeatedly, on many jobs, over a long period.

The blanket is made in standard sizes and it is used in the same way as ordinary burlap.

New Removable Drill Bit

After three years of experimental and development work the Timken Roller Bearing Co., Canton, O., recently put on the market a new type of removable drilling bit. The Timken bit is held tightly against an upset shoulder on the steel by means of a special thread designed for strength and easy removability. This left hand thread is opposed to the direction of rotation of the steel so that the bit is kept tightly against the shoulder while drilling. The hammer blow is transmitted from the steel through the shoulder to the body of the bit. None of its force is absorbed by the thread.

Timken Bit

When a Timken bit becomes too dull for further service it is merely removed and replaced with a new one—a matter of seconds.

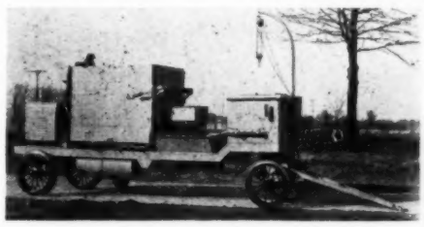
These bits are forged from a special alloy of fine grained steel made in electric furnaces and carefully heat treated to give maximum strength, life and wear resistance. Therefore, aside from the economies resulting from the elimination of re-sharpening the bits, a much longer drilling life is claimed for these bits which have already been adopted for production use on many large drilling operations throughout the country.

Street and Highway Repair Truck

A new model street and highway maintenance machine is announced by the White Mfg. Co., Elkhart, Ind., for state, county and municipal bituminous road and street repair work, or resurfacing of brick and concrete.

The machine is designed to make any formula mix for base binder or top—sheet asphalt, cut back, oleum spirit and other volatile mixtures, to match any type of old pavement or to furnish a fine mix for resurfacing hard pavements. The machine contains stone and sand dryer, pug mixer, detachable bucket elevator, tar kettle, oil burners, measuring devices and is mounted on rubber tired wheels.

The Model L-1 is a complete small asphalt plant to produce high temperature mixes for immediate hot application or cooler mixes for deferred or cold laying. This model follows the general design of the Chausse-White street repair trucks which have been widely used. The new design, however, makes it applicable for production of cold laying mixtures by building the pug mixer in the open and away from fire. Previous models were confined to hot mixing and the location of the pug mill adjacent to burners prevented



White Highway Repair Truck New Model L-1

the use of highly volatile bituminous oils.

The advantage claimed for this machine is in enabling the use of local aggregate and local labor for making maintenance material. Crushed stone, screened or bank run gravel, slag, sand, etc., can be dried and heated and mixed with asphalt, tar, road oil, cut back or emulsion. The machine can also be used to mix concrete and in winter the stone, sand and water can be heated. Its capacity is rated at 25 tons per day of high temperature mix and 40 tons per day of low or medium temperature mix.

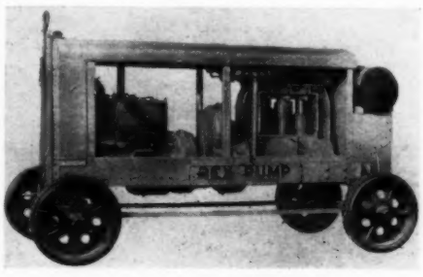
In operation, the dryer is fed by the detachable bucket loader. The rotating dryer is mounted on SKF bearings, heated by three self-generating oil burners, and has internal blades for cascading the material and advancing towards the discharge end.

The aggregate is measured in a 4 cu. ft. capacity hopper with bottom gate which discharges directly into the pug mixer. The bitumen is heated in a 150 gal. tar kettle and is measured in a trough graduated to 6½ gal. capacity for 12 per cent mix. The mixed material is discharged from the pug mixer either directly into a wheelbarrow, on to a belt conveyor, or (by raising machine or digging pit), directly into a truck body.

The machine is fully portable, equipped with towing tongue and weighs 8,000 lb.

Rex Automotive Road Pump

A pump, embodying features of automotive design, has been placed on the market by the Chain Belt Co., Milwaukee, Wis. It is claimed this Rex road pump will deliver 80 gal. at 500 lb. pressure or 125 gal. at 320 lb. pressure, and can be changed from one to the other in the field.



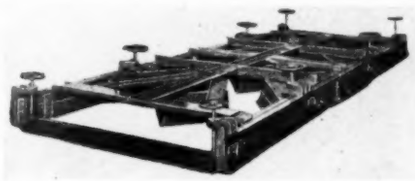
Rex Road Pump

With the Rex automotive design, the pump and reduction case are lubricated just like automobile engines. The pump is vertical, works off a crankshaft below just as does the 25 h.p. Waukesha engine drive through an automotive type Twin Disc Clutch, and heat treated reduction gears, running on anti-friction bearings. The valves and bearings are easily accessible.

The overall design of the pump and chassis is clean and strong, much like an automobile, with low center of gravity and trailer type steering provide a short turning radius, so that it can be readily placed and moved on stream banks, in the hole, or in the ditch.

Hvass "Retread" Mixer-Leveler

A new mixer-leveler for retread construction has been brought out by Chas. Hvass & Co., Inc., 508 East 19th St., New York, N. Y. The mixer-leveler can be drawn from either end by a tractor or truck, thus eliminating the necessity of turning it around. When it is drawn through the loose stone after the bituminous material has been applied the curved blades mounted on the diamonds roll the stone over many times. The bituminous material is lifted from the top of the base



Hvass "Retread" Mixer-Leveler—Showing Mixing Blades and Leveling Blade Lowered

where it penetrates after application by the curved blades. This plowing action is stated to thoroughly coat the stones with bitumen.

The runners on each side of the mixer-leveler can be raised or lowered to slide on either the raised finished half of the road or the shoulder while the center or mixing section rides close to the base to lift all stones and bituminous material lying there. Raising and lowering of runners are made by hand wheels and adjusting screws. An adjustable leveling blade is placed on each end of mixer-leveler so that coated stones can be leveled off after passing through mixing blades. Leveling blades are adjustable by means of hand wheels and screws to give required thickness and crown.

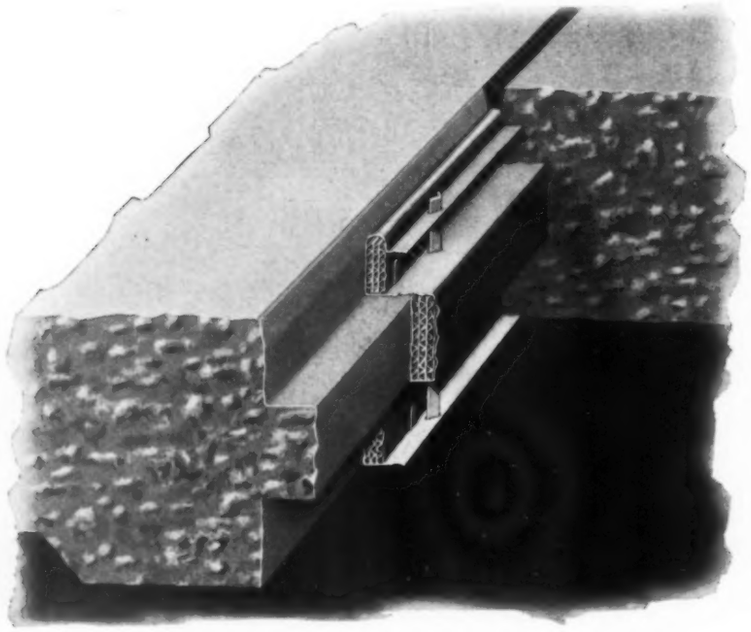
The mixing frame is 24 ft. long, and the runners 28 ft. long, thus overcoming small depressions or hills in the base. The weight is such that it will hold itself down on the road when drawn through the stone. The mixer-leveler can be knocked down to make transportation from job to job comparatively easy.

Expansion Joint for Concrete Paving

A new air-lock expansion joint has been brought out recently by W. S. Godwin Co., Inc., Race and McComas Sts., Baltimore, Md. The joints are strongly formed from sheet steel in any desired lengths and in heights and styles required by different paving specifications. Air spaces are provided by means of inserted strips of waterproofed material, held in place by clips stamped from the sheet steel. Each complete section is coated with asphaltic paint.

Sections are set ½ in. to 1 in. below the pavement surface and are securely and accurately held on the subgrade with heavy steel stakes, which are driven through holes already punched in the steel and remain in place after the concrete is poured.

The air-lock expansion joint acts as a form while the concrete is setting. After the joint is formed in the concrete, it is sealed with hot asphaltic cement.



Godwin Air-Lock Expansion Joint

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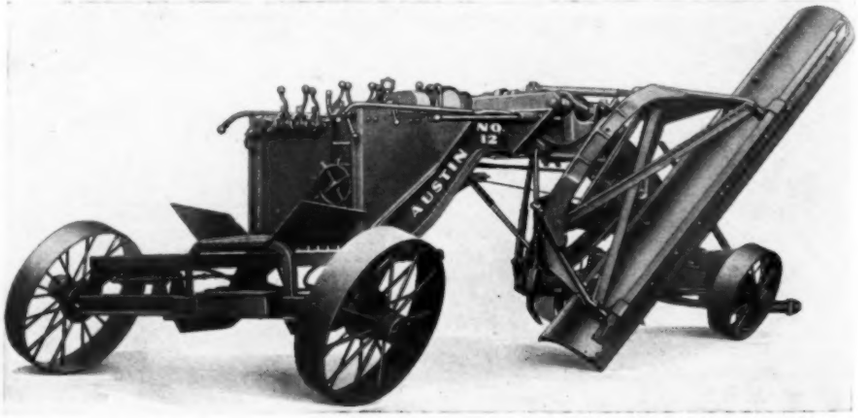
New Austin (Hydraulic) Power Controlled Grader

According to the Austin-Western Road Machinery Co., 400 North Michigan Ave., Chicago, Ill., the new Austin No. 12 grader is a super-rugged unit of simplified, improved design. Heavy 12-ft. blade, with railroad rail reinforcement, cuts 18 in. below ground level, has a high reach of 7 ft. 10 in., and can be raised into high lift position in less than 3½ minutes.

The newly developed (hydraulic) power control provides a fast, smooth and easy means of leaning wheels, shifting rear axle and operating blade, pole steer and scarifier. A rotary pump actuates the rams that work within double acting, high pressure cylinders. Moving parts are few (only nine) and they always work in oil. Pump rotates constantly, but does not operate under load (or against relief valve) when blade, wheels, etc., are in hold or "locked" position. Both ends of blade can be lowered or raised individually or simultaneously.

Other interesting features of construction include a one-piece girder type frame of welded construction that is capable of resisting enormous strain and twist; its design also permits a greater high lift angle and a better view of working blade.

Wide reach, telescopic blade lift arms have finished ball and socket joints. Z-bar draft beam has unique ball joint connection and special lowering device; line of draft is straight and direct; no power is applied through frame. Engine hitch, with universal joint draft connection, can rise or fall 44 in. from normal position. Extra large diameter, one-piece cast steel circle is accurately machined for smoother operation. Axles have over-size drop-forged spindles, and are equipped with tapered roller bearings. Built up front end of welded construction is flexibly designed to permit either front wheel to operate 36 in. above the other. Simplified rear end using high carbon steel angles provides 20 in. of ground clearance. All wheels have hot riveted countersunk spokes and tires of generous width.



New Hydraulic Austin No. 12, Leaning Wheel Blade Grader

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Paints for Traffic Markings

A series of paint materials for traffic markings on highways and streets, designed to stand up under the difficult conditions existing in markings such as these, has been developed by the Finishes Division of the du Pont Company, Wilmington, Del. Tests were made in six states under various traffic conditions to determine how long it took for the paint to dry tack free and also how long to dry hard. It was found that four of them showed characteristics of drying in approximately the same short time as lacquer type materials. Others took somewhat longer. Three colors were used, white, yellow and red. Because of the severe tests demanded of these traffic marking paints, considerable care was taken to try them out where many different climates would be encountered. The tests ran from Texas and California to Ohio, Pennsylvania, Massachusetts and North Carolina.

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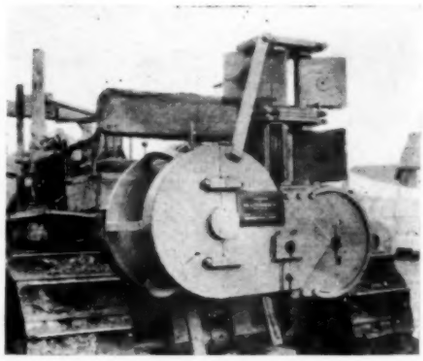
New Cable Power Unit

R. G. Le Tourneau, Inc., Stockton, Calif., has placed on the market a new logging type cable power unit, which, beside providing the operator with a high-speed power drum for handling cable-controlled machinery such as a bulldozer, cowdozer or rooter, affords him a heavy drum for tough pulls, pulling stumps, bunching logs,



New Logging Type Cable Power Unit

logging short shows, etc. The new unit fits all large tractors.

The two drums can be operated independently, either while the tractor is in motion or standing, and both lines run through fairleads which enables them to pull in any direction regardless of how the tractor is headed. The large drum handles 580 ft. of ¾ in. cable; the small drum 920 ft. of ½ in. cable.

All shafts are heat-treated nickel-steel; gears are case-hardened nickel-steel and run in oil; bearings are high duty Hyatt and Timken. The brake has a patented feature which permits the drum to spin absolutely free when the lever is thrown to release position but automatically grips when the clutch is released.

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Largest Walking Dragline

A new 10-yard walking dragline with 160 ft. boom has been developed by the Bucyrus-Monighan Co. This new model is stated to be the largest walking dragline ever built. The structure of the Bucyrus-Monighan 10-W is similar to other machines produced by the company, but is, of course, greatly strengthened throughout to meet the much higher stresses imposed by handling such a large bucket on a long boom.

A feature which is very important to the operator and owner of the machine is the location of the operator's cab. This has been elevated highup in the front right hand corner, and gives the operator an unobstructed view of the bucket and the work. The walking traction of this machine is stated to operate just as smoothly and is just as easily controlled as on the smallest Bucyrus-Monighan walker.

The walking traction shoes are raised high above the ground while the machine is excavating, during which time it rests on an independent circular base of large area. The direction the machine is to travel is changed, while it is standing on its circular base, by simply revolving the swinging platform to which the walking shoes are attached. The shoes, elevated above the ground, are thus pointed in the direction it is desired to move, the walking mechanism starts operating and the machine moves off in a direct straight line toward the desired position.

Bucyrus-Monighan Walking draglines are sold by Bucyrus-Erie Co., Department LF-11, South Milwaukee, Wis.

New 10-yd. Bucyrus-Monighan Walking Dragline With 160 ft. Boom

is fully reversible and can be towed from either end, thus eliminating the delays often made necessary by maneuvering to get in position or in turning around. Dual end steering makes it follow the turning radius of the truck and eliminates the dangers in swinging wide on the curves. Braking at both ends assures full control at all times. The wheels roll on heavy duty Timken bearings and the platform is supported by a series of heavy freight car type coil springs, a new and exclusive spring feature which permits the wheels to follow the contour of the road surface without disturbing the level of the loading platform. The loading platform is flat and no excess weight is wasted in providing for heavy steering turntables.

Loading can be done over either end, or side and skid ledges are provided.

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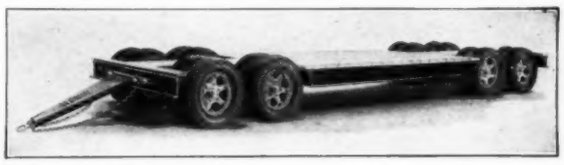
New Tandem Axle Machinery Trailer

The C. R. Jahn Co., Builders' Bldg., Chicago, has announced a new tandem axle La Crosse trailer retaining all of the fully reversible advantages of the regular dual axle models. This new design conforms as to axle load limits and trailer width regulations of most states.



New Tandem Machinery Trailer

The trailer is under 8 feet, in width overall, is mounted on pneumatic tires, and is built in sizes up to 72,000 lb. capacity. It

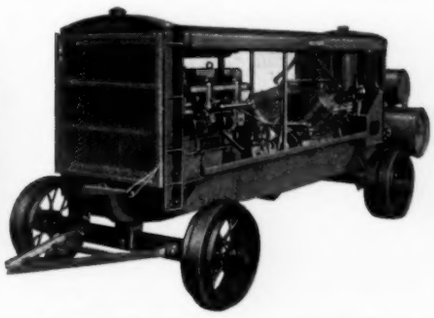
New Sullivan 505-Ft. Portable Compressor

The Sullivan Machinery Co., 400 North Michigan Ave., Chicago, Ill., has placed on the market a new sized portable air compressor, providing 505 cu. ft. displacement against the customary working pressure of 100 lb. per square inch.

The familiar Sullivan design has been followed in general, maintaining the essential characteristics of mobility, dependability and simplicity. This Sullivan unit is a 2-stage, 4-cylinder type compressor, powered by a 6-cylinder Climax engine, coupled to the compressor by the standard Sullivan gear type coupling, with twin disc clutch and self-starter. The entire rig is mounted on a heavy fabricated steel plate frame and mounted on steel wheels with rubber tires, with single tires on the front wheels and dual tires on the rear wheels.

A 4-cylinder "V" - type compressor is used, following the pioneer Sullivan idea in larger capacity portable compressors. Its smoothness of operation and freedom from vibration is stated to be noteworthy in a machine of this size and power. Two low pressure cylinders 11½ in. in diameter are set on one side of the crank shaft and two high pressure, or discharge, cylinders 6½ in. in diameter are set on the other side of the same crank shaft. An intercooler is provided between the two stages, situated just in the rear of the compressor unit. High actual air delivery and power economy follow this design. Sullivan standard "wafer" valves are used throughout. The cooling system for the compressor and intercooler is separate from that for the engine. A sectional tubular radiator is located at the rear of the mounting and the fan and circulating water pump are driven from the compressor shaft. Lubrication is of the gravity and splash type. The compressor control includes pilot valve, Sullivan inlet valve unloader and Sullivan automatic throttle control. When the compressor unloads, the engine is slowed down to idling speed. The timing is such that the compressor is fully unloaded before the engine speed is reduced; and the engine is up to normal speed before the compressor takes up its load again.

A 55-gal. gasoline tank is mounted in a cradle at the rear of the rig.



Sullivan 505 Ft. Portable Compressor

Distributor News

New President of Sullivan Machinery Co.

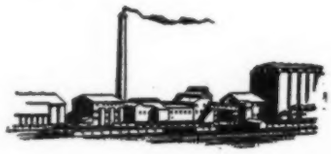
Sullivan Machinery Co., Chicago, announces the election of Arthur E. Blackwood as chairman of the board of directors, and of Henry S. Beal as president, to succeed Mr. Blackwood. Henry S. Beal, the new president of Sullivan Machinery Co., was born in Rockford, Ill., in 1888. He attended Dartmouth College and the University of Berlin. He has been with the Jones & Lamson Machine Co., machine tool manufacturers, of Springfield, Vt. since 1909, starting as a machinist, then traveling demonstrator, manager of cost accounting, sales manager and general manager. Among outside activities, he has been a director of the National Machine Tool Builders' Association for the past three years and also its president. Arthur E. Blackwood, recently elected chairman of the Board of Directors, has been with the Sullivan Machinery Co. since 1897. Until 1919 he was manager of the New York City sales office. In the latter year he came to Chicago as vice-president in charge of financial matters, and was elected president following the death of the late Frederick K. Copeland, four years ago. Mr. Blackwood is vice-president of the Chicago Metal Trades Association.

New Distributors for Heltzel

The Heltzel Steel Form & Iron Co., Warren, O., has recently appointed the following new distributors: F. H. Burlew Company, 221-225 West Huron St., Chicago, Ill. (handles Heltzel bin, batcher and bulk cement account); The Cook & Brown Lime Co., Oshkosh, Wis. (handles entire Heltzel account); Arthur W. Davis, 324 West Georgia St., Indianapolis, Ind. (handles Heltzel bin, batcher and bulk cement account); Industrial Machinery Co., 430-32 Minnesota Ave., Kansas City, Kan. (handles Heltzel bin, batcher and bulk cement account); H. O. Penn Machinery Co., 140th St. and East River, New York, N. Y. (handles Heltzel bin, batcher and bulk cement account).

Northwest Announces New Distributors

Three equipment distributors in Baltimore, Cincinnati and Detroit have recently been added to the sales organization of the Northwest Engineering Co., Chicago, Ill., manufacturers of excavating and material handling equipment. In Baltimore, John C. Louis, Inc., will handle the Northwest account in the state of Maryland and Washington, D. C.; in Cincinnati, the Northwest account will be handled by a new distributor's organization known as the Blaisdell & Folz Equipment Company. Messrs. A. C. Blaisdell and R. G. Folz were for years affiliated with the Queen City Supply Co. of Cincinnati and have recently formed a new organization to handle contractors' equipment. In Detroit, C. J. Burke, who



has been prominently identified with construction equipment in that city for the past 13 years, will handle the Northwest account in eastern and southern Michigan.

Name W. D. M. Allan Director of Promotion for Portland Cement Association

Announcement is made by Wm. M. Kinney, general manager, Portland Cement Association, of the appointment of W. D. M. Allan, manager, cement products bureau, since 1926, as director of promotion, with responsibility for the planning and direction of the work of the following six departments: Advertising and Publications, General Educational, Cement Products, Highways and Municipal, Railways, and Structural Bureau. W. G. Kaiser, assistant manager, cement products bureau, for over 10 years, is named manager to succeed Mr. Allan. These changes became effective March 22. Mr. Kinney also announces that C. R. Ege, manager, advertising and publications bureau, has been appointed assistant secretary, Portland Cement Association, by the board of directors. Both Allan and Kaiser are well known to the concrete industry. The former has been intimately associated with work of Portland Cement Association, American Concrete Institute, Concrete Masonry Association, National Ready-Mixed Concrete Association and other similar organizations, both local and national, since 1918. The latter, one of the original employes of the cement products bureau, advancing from agricultural engineer to assistant manager, also is a past president of the American Society of Agricultural Engineers.

FWD Appoints A. J. Steffick as District Sales Supervisor

The Four Wheel Drive Sales Co. of Clintonville, Wis., has announced the appointment of A. J. Steffick as district sales supervisor for the states of Utah, Idaho, Montana, and the Yellowstone Park District. The new plan, effective Feb. 18, will mean a reduction in the size of the territories formerly served by factory representatives E. M. McLean and P. M. Schmidt, and will make possible more frequent contacts with dealers, prospects, and FWD truck operators. This change in districts is in line with the 1933 FWD sales program whereby more concentrated sales effort will be made in selected territories and markets. Mr. Steffick has been employed by the FWD Company for the past several years in the capacity of a traveling service engineer and is well acquainted with hauling problems in the mountain states region. This promotion will still enable him to keep in touch with the many operators of FWD equipment in the territory he formerly covered as a service engineer. His headquarters will be at the Bannock Hotel, Pocatello, Idaho.

Superior United Corporation Organized

A new contractors' equipment company has been organized in Chicago. This company, the Superior United Corporation, incorporated under the laws of the state of Illinois, and also licensed to do business in Indiana, is made up of the Superior Construction Equipment Co., The G. F. Lowe Co. and Mr. Hillsman, formerly president of the G. E. Hillsman Co. The personnel of the new company consists of Will Sostheim and John Erby of the Superior Construction Equipment Co., G. F. Lowe of the G. F. Lowe Co., and G. E. Hillsman, who will devote all of their time to direct selling. O. E. Quinton, who had been the treasurer of the Superior Construction Equipment Co., will act in that capacity for the new company as well as to manage the office. The major accounts of the Superior United Corporation are the entire Chain Belt line, Butler Bin Co., Le Roi air compressors, Byers, and Heltzel forms. The offices, warehouse, show rooms and service station are located at 1850 S. Kostner Ave., Chicago, Ill. The company will offer sales of new and used equipment, rentals and service. The officers are: G. F. Lowe, president; W. R. Sostheim and G. E. Hillsman, vice-presidents; John Erby, secretary; O. E. Quinton, treasurer.

Goodrich Raises Pay of All Salaried Employees

The following statement has been issued to all employes of The B. F. Goodrich Company throughout the United States by J. D. Tew, president: "The Administration at Washington is aggressively putting into effect constructive legislation which, in our opinion, will soon result in greater business activities. The measures enacted are most helpful in restoring confidence and opening up avenues of trade. In the hope that the actions taken in Washington will be productive of increased business, and in order to support every move for the restoration of normal business, all salaried employes of the parent and domestic subsidiary companies were restored on March 20 to rates effective prior to the recent national financial emergency."

New Littleford Distributors

Since the first of the year, the distributing organization of Littleford Bros., Cincinnati, O., has been increased by three new connections. They are: The Smith Booth Usher Co. in Los Angeles; R. W. Simpson in Des Moines, Iowa; The Ray Corson-Elkins Co. in Denver, Colo.